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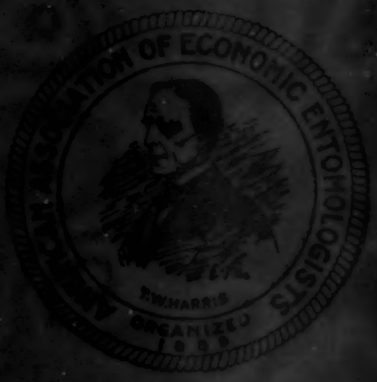

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THE PRESENT STATUS OF THE GLADIOLUS THRIPS IN THE UNITED STATES

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ABSTRACT

The present distribution, economic importance, and seasonal history, including overwintering, of this thrips (*Taeniothrips gladioli*) are discussed. Observations on the effectiveness of control measures employed by commercial growers are also presented.

The gladiolus thrips (*Taeniothrips gladioli* M. & S.) has continued to be a serious pest of gladiolus during the past year and has caused severe injury over a considerably greater area than previously reported. Since the flowers are so popular with home gardeners, the destructiveness of this insect has been particularly felt by them, not to mention the huge losses sustained by the commercial growers.

According to the present records, based upon specimens received and identified by Dr. H. Morrison, of the Bureau of Entomology, this thrips is now known to occur in California, Connecticut, Georgia, Indiana, Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Virginia and West Virginia. It has also been reported from Florida, Kentucky, Illinois, Missouri and

[1]Through the courtesy of Prof. P. J. Parrott, of the New York State Agricultural Experiment Station, Dr. F. L. Gambrell aided in the surveys made in western New York. Several gladiolus growers, particularly Mrs. Stella M. Antisdale, of the American Gladiolus Society, and Mr. Henry Breuss, of Hamburg, N. Y., have facilitated the gathering of much valuable information pertaining to this pest.

Wisconsin. The insects appear to have been especially abundant and destructive during the past season in the Eastern Atlantic States.

In addition to the gladiolus thrips, the following eleven species and varieties of thrips have been collected on gladiolus during the past season:

Aeolothrips fasciatus Lind.
Chirothrips manicatus Haliday
Frankliniella fusca Hinds
Frankliniella nervosa Uzel
Frankliniella occidentalis Perg.
Frankliniella tritici Fitch
Frankliniella tritici var. *bispinosa* Morgan
Heliothrips femoralis Reuter
Limothrips cerealium Haliday
Sericothrips cingulatus Hinds
Thrips tabaci Lind.

During the early part of the season the tobacco thrips, *F. fusca* Hinds, was very abundant in most gladiolus plantings and caused considerable confusion among the growers. This was due to their inability to distinguish this form and its injury, as well as the others mentioned above, from the gladiolus thrips on this host, as well as on the many other hosts upon which these and other thrips often occurred.

INJURY AND ECONOMIC IMPORTANCE.—The direct injury caused to the foliage and flowers has already been described in a previous article.[2]

The gladiolus thrips, in feeding on the corms during the storage season, disfigure the surface by causing injury to the cells, which is followed by suberization. Their feeding at the base of the corms on areas from which the roots arise causes the death of these rootlets or root buds, and new ones must be formed from the tissue beneath, thus slowing up root development after the corms have been planted. Direct injury to the sprouts also occurs in storage. The combined effect of these injuries is retardation and stunting of growth and the production of smaller flowers. In some instances the corms produced a weak growth which died as the corms rotted. Considering the injury to the foliage, flowers, and corms, the economic importance of this pest can be readily appreciated.

In addition to its importance as a pest to outdoor-grown gladiolus, florists in the District of Columbia, Maryland, and Virginia suffered a complete loss of the flowers from corms forced in the greenhouse, in certain instances from corms which were known to be infested but not treated before planting.

HOSTS.—In addition to the natural infestation on tigerflower (*Tigridia* sp.) Montbretia (*Tritonia* sp.), and the torchlily or pokerplant (*Knip-*

[2]Smith, Floyd F., and Weigel, C. A. Taeniothrips gladioli M. & S., a New Pest of Gladiolus, Jour. Econ. Ent. 25: 312–318, illus. 1932.

hofiia spp.) occurring in the field, as previously recorded,[3] this thrips has been reared on foliage of Japanese iris and on the dormant bulbs of Spanish iris. An occasional adult has also been found on Coreopsis and on other plants that have been previously reported,[3] but breeding was not observed in these instances.

SEASONAL HISTORY.—From the studies thus far conducted it is evident that these thrips are taken into storage when the crop is harvested, continue to feed and breed on the corms throughout the winter, and are taken to the field when the corms are planted. As the young sprouts push their way through the soil the thrips follow and immediately attack the new growth. The thrips begin breeding at once and increase in numbers until flowering time, when the population reaches its maximum. They become greatly diminished at the end of the flowering season, whether the flower is cut or is allowed to mature on the plant. A few, however, persist on the plant as long as the foliage remains green. In general practice it is customary to harvest the crop while the foliage is still green and the thrips are still present. While the corms are drying in the field, the thrips have an opportunity to crawl to the corms or are shaken onto them when the tops are cut off, and in this way are taken into storage. Observations thus far indicate that the thrips apparently do not infest the corms in the fall, while they are still in the ground, except when corms are exposed by erosion or cracking of the soil. It has also been observed that where harvesting was delayed until the tops had died completely and left no food for the thrips, the corms were dug and harvested without developing infestation. While this procedure demonstrates the possibility of harvesting the crop without its becoming infested, such a practice has certain drawbacks which would not be acceptable to the growers. The almost necessary commercial practice of digging the crop while the tops are still green and thrips are present is unfortunate, since this is the principal means by which the thrips gain access to the storage from the field.

OVERWINTERING OUT OF DOORS.—Probably the most important point in the development of this insect from the standpoint of control hinges on whether it overwinters successfully out of doors. Although some evidence is now available that it does not overwinter in the field in the Northern States, further data are needed definitely to establish this point. The evidence at hand includes the following points: (a) Thrips did not survive in New York State and in Washington, D. C., on caged or uncaged infested tops that were left in the field over winter. (b) They did not survive on corms of infested plants left undug in the ground.

[3]Op. cit.

This point was established by examining corms dug in the spring and by the absence of thrips on the flower crop produced from the undisturbed corms in two fields. This is in marked contrast to the complete loss of flowers during the preceding season. (c)There were no thrips on Japanese and German iris and poker plant in the spring of 1932, although they were present in the fall of 1931, as verified by field and caged material. (d) A thrips-free crop of gladiolus was grown in 1932 in the same or adjacent fields and gardens following effective treatment of the corms from the severely infested crop of 1931. This was definitely demonstrated in 5 cases in New York, in 2 in Ohio, and in 1 in Virginia.

NATURAL ENEMIES.—The predator (*Triphleps*) *Orius insidiosus* (Say) has been found to be associated with practically all infestations of this thrips and appears to have a limiting effect on its abundance. With one possible exception, however, it has not been able to reduce the numbers to a point sufficient to prevent flower injury.

EFFECTIVENESS OF CONTROL MEASURES EMPLOYED BY GROWERS.—*Treatment of corms*. Since it is now recognized that the planting of infested corms will result in establishing infestation in the growing crop, the necessity of effective corm treatment to eliminate this source of infestation is evident. On the basis of preliminary recommendations that were presented in the Florists Exchange,[4] commercial growers employed some of these remedies, together with others not suggested, and the results which they obtained have been observed. These treatments included the following:

(a) Calcium cyanide. One grower who fumigated his stock failed to control the thrips because he allowed too great an interval between the fumigations. Three other growers obtained good results, except in stocks where the scales were moist, which apparently prevented the proper diffusion of the gas.

(b) Bichloride of mercury. This chemical has not proven entirely effective on unpeeled corms, according to the results obtained by five growers, where the immersion period was from 3 to 7 hours or overnight.

(c) Semesan. One grower successfully eliminated thrips on 10,000 corms that were immersed 17 hours in Semesan solution—1 pound to 50 gallons of water— and obtained similar results on 75,000 corms treated for 7 hours in a solution of 1 pound of Semesan to 10 gallons of water.

(d) Tobacco dust. One grower found that this material was not completely effective where the corms in the trays received a heavy applica-

[4]Weigel, C. A., Smith, Floyd F., and Richardson, Henry H. The Gladiolus Thrips. Florists Exchange 79: 11, 40, 80B, No. 11, March 12, 1932.

tion, since a few living thrips were observed beneath the scales of some corms three months after treatment.

(e) Ethylene dichloride-carbon tetrachloride mixture. Two growers successfully controlled the thrips with this mixture where the proper precautions as to dosage and exposure were observed. One grower who observed these precautions allowed reinfestation of his treated stock to take place because he did not isolate it from the untreated stock, and thus failed to control the thrips. The corms of four growers who employed much larger dosages or longer exposures than recommended were so severely injured that they were practically a complete loss.

(f) Lye solution. One grower immersed his corms, before planting, in a solution containing one pound of sodium hydroxide in 20 gallons of water for a period of 24 hours and failed to control the thrips. Incidentally, he also treated his stock at digging time in a solution containing 1 pound of copper sulphate in 10 gallons of water, followed by one fumigation with calcium cyanide, without the desired results.

(g) Naphthalene flakes. Three growers who fumigated their entire stock with this material before planting obtained complete control of the thrips and grew a normal crop of flowers.

Of the seven corm treatments for thrips control employed by the growers that have been observed, immersion in Semesan, fumigation with the ethylene dichloride-carbon tetrachloride mixture, and fumigation with naphthalene flakes, were completely effective. It now appears that treatment with naphthalene flakes is most suitable to the average grower when effectiveness, economy, and absence of danger of injury to the corms by overdosage are considered.

Treatment of the growing crop. Thus far no definite observations have been made on the effectiveness of sprays and dusts, including combinations with nicotine, Bordeaux mixture, pyrethrum, and derris, applied by commercial growers for the control of this thrips under field conditions. However, information gleaned from correspondence with growers indicates that no entirely successful control was obtained by the methods they used.

Observations in several greenhouses showed that the thrips was not controlled where the florists sprayed twice weekly with a strong solution of free nicotine or pyrethrum extract or where they applied naphthalene flakes to the surface of the soil of the bed in which the plants were being forced.

SUMMARY AND CONCLUSIONS.—The gladiolus thrips has continued to be a serious pest during 1932 over a larger area than previously reported. Eleven other species of thrips have been collected on gladiolus and

evidently these have often been confused with the gladiolus thrips. In addition to the injury to foliage and flowers, the thrips, by feeding on the stored corms, cause injury to the corm surface, rootlets and sprouts, which results in a retardation of the development of roots and sprouts when the crop is planted. The resulting growth and flowers may be stunted, or, as in severe cases observed, the plants may fail to grow. The thrips has been reared on the foliage of Japanese iris and on the bulbs of Spanish iris.

The thrips is taken into storage at harvest time and breeds in storage until planting time, when it is taken back to the field. It then increases in numbers and injures the foliage and flowers. In cage tests and field observations the thrips failed to overwinter on other host plants out of doors, in piles of gladiolus tops, or on corms in the soil. Further evidence of the non-overwintering of this thrips was observed in 7 cases in which a thrips-free crop was grown in 1932 in the same fields in which the 1931 crop was severely infested, or in adjacent fields.

The predator *Orius insidiosus*, while commonly present in the field, has failed to prevent serious flower injury.

Of the various corm treatments employed by commercial growers, the immersion in Semesan solution, or fumigation either with naphthalene flakes or with the ethylene dichloride-carbon tetrachloride mixture, give complete control. The last-named fumigant caused severe injury when improperly used, that is, when an overdosage or overexposure was employed. Naphthalene flakes appear to be the most suitable corm treatment for use by the average grower.

LIFE-HISTORY STUDIES OF THE GLADIOLUS THRIPS (*TAENIOTHRIPS GLADIOLI* M. & S.)[1]

By Floyd F. Smith and R. H. Nelson, *U. S. Bureau of Entomology, Washington, D. C.*

Abstract

The cages used for life-history studies of the gladiolus thrips on corms and growing plants are described. Data on habits, parthenogenesis, oviposition, and development, at controlled temperatures on stored corms and on plants in the insectary, are given.

Information on the life history and development of the gladiolus thrips is of direct practical value in applying control measures to the stored gladiolus corms, in determining proper temperatures for storing

[1]Order Thysanoptera, family Thripidae.

corms,[2] and in field control. In order to obtain this information detailed studies on the oviposition and development of the thrips were conducted on dormant corms during the 1931–32 storage season, and on the aerial growth during the summer of 1932 in the insectary. The present paper describes the technic used in conducting these studies and presents the data obtained on the life history of this insect under both conditions.

TECHNIC.—For life history studies in storage, cormels, removed from their covering, were used as food for the thrips, since they were readily obtained free of infestation,[3] and were of convenient size for making observations. They were impaled on the point of a pin thrust through a cotton stopper and placed in a vial (Plate 24) cage for exposure to the ovipositing adults, for incubation of the eggs, for larval development, and for pupation records. A round-bottom vial is more desirable for observation than the flat-bottom type shown, but is less convenient in other respects.

For insectary studies the cormels were germinated at a temperature of 90° F. in moist sand and potted into 2½-inch pots. When the sprout reached 2 or 3 inches in height the plant was caged (Plate 24) with a 1 inch by 5 inch open-end vial which was provided with a cloth-covered cotton stopper. The vial was held in position by means of a rubber band and a plant label forced into the soil. Disturbed thrips often descend the plant and hide among the soil particles, so white sand was poured over the soil surface in the cage as an aid in locating the insects, particularly the adults. Both types of cages supply the insects with normal plant tissue yet permit thorough examination under the wide-field microscope. To enable the insects to regain the plant tissue if they jumped off, and to supply a favorable feeding place, the vials were always adjusted so that the leaf or cormel rested against the side.

The life-history pairs were transferred daily for obtaining oviposition records. Larvae, hatching from eggs placed in the plant tissue, were transferred to separate cages for rearing to adults. All transfers were made with a camel's-hair brush; the adults without magnification, the other stages under a low-power binocular.

STAGES OF THE INSECT.—The immature stages of the gladiolus thrips in general resemble those of the pear thrips, *Taeniothrips inconsequens* Uzel, in that there are two active larval instars and two pupal instars.[4]

[2]Weigel, C. A., Smith, Floyd F., and Richardson, Henry H. The Gladiolus thrips. Florists Exchange 79: 11, 40, 80B, illus. March 12, 1932.

[3]Smith, Floyd F. The natural protection of gladiolus cormels from thrips' attack. Jour. Econ. Ent. 25: 1110. 1932.

[4]Foster, S. W., and Jones, P. R. The life history and habits of the pear thrips in California. U. S. Dept. Agr. Bul. 173, 52 p., illus. 1915.

However, the gladiolus thrips does not construct a cell of any sort for the pupal stage, even when pupating in the soil. The eggs, placed within the leaf or corm tissue by the ovipositing females, are kidney-shaped, translucent or opaque in appearance, and measure 0.3 mm. in length and 0.11 mm. in diameter.

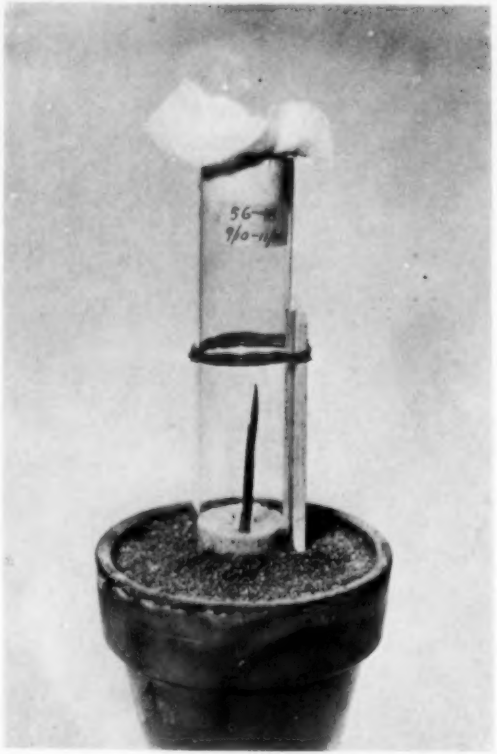
In hatching, the insect within the unbroken chorion forces the fore part of the body outside the plant surface. The chorion is then ruptured and the milky-white larva emerges. The newly hatched larva measures about 0.5 mm. in length. Feeding soon begins and the body color changes to a lemon yellow, which is maintained through the larval and pupal stages. During the larval stages, however, certain colors, due to ingested chlorophyll from leaves or other coloring material from flowers or corms, are visible through the body wall. This coloring matter taken up with the food is apparently undigestible, as shown by the dried particles of colored fecal matter.

The first two molts are preceded by brief quiescent periods. The two stages of the pupa are distinguished by the short wing pads of the first and the long wing pads of the second. The insect does not feed in either pupal stage and moves about feebly only when disturbed.

In the molting process the caudal end of the body is attached to the leaf or corm surface, and, after splitting the dorsum of the covering anteriorly, the insect pulls itself out of the old skin. The process required from 2 to 4 minutes in the many observed cases.

At first the adults are milky white but soon become darker and start to feed. They mate and lay eggs on the first or second day. The male and female adults are readily distinguished, and the sexes can be recognized in the last pupal stage.

Life History and Development in Storage. During the winter of 1931-32 four series of tests on the oviposition rate of adults and on the periods of incubation and development of the thrips were conducted at constant temperatures in an air-conditioning cabinet at 50°, 60°, 80°, and 90° F. In addition a series was conducted in the greenhouse laboratory at approximately 70° F. The results on the various phases of the life history of 29 females and 20 males in the 70° series are summarized in Table 1. These 29 females, and one other which escaped after having laid 167 eggs, deposited a total of 3,566 eggs. Usually only one or two eggs are laid on each of the first few days of adult life, but the rate soon increases. The greatest number of eggs laid in one day by one female was 18. In this series 50.1 per cent or 1,788 of the eggs were laid during the first two weeks of adult life, and 87.2 per cent or 3,111 eggs were laid by the end of the fourth week, although surviving females laid eggs dur-



Assembled cages used for life history studies; left on cormels; right on growing plant.

ing the ninth week. In comparing the daily oviposition rates of individuals during the first two weeks of adult life, 0.41 egg per day were laid at 50° F., 1.38 eggs at 60°, 4.11 eggs at 70°, and 7.19 eggs at 80°. The adults held at 90° were adversely affected by the high temperature and soon died without laying more than a few eggs. These studies indicate that the optimum temperature for most rapid reproduction in storage is probably near 80° and that 50° and 90° represent the approximate extremes for oviposition.

The data on incubation and development of the thrips on cormels at the various temperatures are summarized in section A of Table 2. Eggs hatched at the 60° to 80° temperature ranges, but none of the hundreds of eggs in cormels held for 4 or 5 weeks at 50° hatched at that temperature or when returned to room temperatures after such exposure. At a temperature of 90°F. and 50 per cent relative humidity no larvae hatched; at 90° F. and 100 per cent relative humidity only 7 larvae hatched from 200 eggs. It is apparent that 50° and 90° represent approximate extremes of temperatures for hatching from corm tissue.

In 13 laboratory tests to determine the effect of cold on the eggs it was found that larvae hatched from eggs in corms which were returned to room temperature after exposure of 4 days or less at 33°F., but that none hatched from corms which had been chilled for 7 to 22 days. The minimum periods of exposure required for preventing the hatching of eggs at various low temperatures, 50° F. or below, are now under investigation. Whether the effect of high and low temperatures alone, or its combination with the suberization of the corm tissue, prevents hatching is yet to be determined. Of practical importance is the apparent prevention of egg hatching at 50° F. or below, and this fact should lead the gladiolus grower to store his stock at a low temperature.

Larvae and pupae completed their stages at temperatures ranging from 50° to 90° F., but the mortality was high at the two extremes. At 50° F. 23 per cent of 200 larvae were reared. At 90° F. and 50 per cent relative humidity none of 207 larvae or of 200 pupae were reared. At the same temperature and 100 per cent relative humidity only 1 of 86 larvae and 11 of 65 pupae were reared. Attempts to rear complete generations at 50° and 90° failed. Although no individuals were reared from egg to adult at 60° F. because the test was closed for other work, it would doubtless have been possible to do so. . A generation would require about 31 days at 60° F., based on the length of the developmental stages. Average periods of 19 and 10.6 days were required at 70° and 80°, respectively, according to actual records. The studies indicate that the most rapid reproduction and development take place at or near 80°F. in storage.

LIFE HISTORY IN THE INSECTARY.—The detailed life-history studies conducted during 1932 were begun June 9 and terminated November 1. The information relative to 17 females and 15 males is summarized in Table 1. Three other females, included in the table under preoviposition period, were lost or accidentally killed, thus terminating the completion of the other records on their lives. The 17 females, which deposited a total of 2,226 eggs, laid 1,198 or 53.8 per cent of the eggs during the first 10 days of adult life and 2,141 or 96.18 per cent of them during the first four weeks, although surviving females laid a few eggs during the seventh week. The daily oviposition of each of these females during the first two weeks of adult life averaged 6.54 eggs, and the greatest number laid in one day by one female was 20.

TABLE 1. SUMMARY OF DATA ON LIFE HISTORY STUDIES OF ADULTS OF *Taeniothrips gladioli* M. & S. ON STORED CORMS AT APPROXIMATELY 70° F. AND IN AN INSECTARY AT SEASONAL TEMPERATURES; WASHINGTON, D. C., 1931–1932

	Individuals observed		Maximum		Minimum		Average	
	Insectary No.	Storage No.	Insectary Days	Storage Days	Insectary Days	Storage Days	Insectary Days	Storage Days
Preoviposition period	20	30	3	15	0	0	0.65	2.8
Oviposition period	17	29	48	63	12	7	26.65	30.58
Postoviposition period	17	29	22	39	0	0	5.41	8.4
Age of females at death	17	29	58	76	13	19	32.82	42
Age of males at death	15	20	49	64	13	10	26.74	42.5
			No.	No.	No.	No.	No.	No.
Eggs laid per female	17	29	202	204	57	7	130.94	117.2

Data on the period of incubation, of the larval and pupal stages, and of the elapsed time from egg to adult are summarized in Table 2, section B. All of the 268 recorded individuals entered the soil to pupate except 25 which pupated on the sides of cages. The thrips pupating in the soil spent from 1 to 5 days longer in the pupal stage than did those pupating above ground in the same cages. This is doubtless due to the lower temperature prevailing in the soil and accounts for the greater length of the pupal stage under insectary conditions. In the studies on corms (Table 2, section A) where all stages developed under the same conditions, the pupal stage was approximately the same or slightly shorter than the larval period.

During the period of June 10 to September 6, six generations were reared to adults at an average rate of one generation in two weeks. Thrips were observed breeding on foliage of gladiolus in gardens as early as May 5, 1932, and as late as December 12, 1931. Based on these observations it seems possible that additional generations could develop

in the spring and in the fall if green foliage were present on the growing gladiolus crop.

TABLE 2. DEVELOPMENT OF *Taeniothrips gladioli* M. & S. ON GLADIOLUS AT WASHINGTON, D. C., 1931–1932

Section A—On dormant corms at temperatures indicated during the winter of 1931–1932

Stage of insect	Temperature °F.	Individuals observed Number	Period of Development Maximum Days	Minimum Days	Average Days
Egg	60	153	15	8	9.97
	70	517	9	5	6.3
	80	271	5	3	3.6
	90	7	6	3	4.7
Larva	50	46	33	22	27.08
	60	49	14	9	11.3
	70	428	9	5	6.92
	80	159	4	3	3.44
	90	1	—	—	4
Pupa	50	26	22	17	19.7
	60	33	14	8	10.3
	70	319	10	4	6.1
	80	73	5	3	3.7
	90	11	4	3	3.63
Egg to adult	70	311	24	16	19
	80	30	12	9	10.6

Section B—In insectary during the season of 1932 at seasonally varying temperatures

Egg	2,090	8	3	4.66
Larva	268	7	2	3.78
Pupa	268	14	3	6.61
Egg to adult	418	25	11	15.5

Since the development of immature stages, the longevity and oviposition of adults, and other points in the life history are so similar at an approximate temperature of 70° to 80° F. on stored corms and on foliage, it appears that the insect thrives equally well on the two types of food. It also appears that development depending upon the temperature, may be continuous throughout the year on gladiolus foliage or on the stored corms and that there is no definite seasonal period of hibernation.

PARTHENOGENESIS AND MATING.—Foster and Jones[5] reported that the pear thrips produced only females without fertilization (thelyotoky) and that males were not found in California. The gladiolus thrips normally mates and the offspring include both sexes, although only 32.5 per cent of the 874 reared offspring of mated females were males. In 15 cases where females were isolated without mating, and their offspring reared to adult, all were males (arrhenotoky). In several tests the

[5]Op. cit., p. 38.

unfertilized females were mated with their own offspring and the eggs laid subsequent to this mating produced both males and females. One female could thus initiate an infestation.

Because of the apparently great attraction between the sexes, and the polygamous nature of the males, it is believed that unmated females are normally rare, even though females are relatively more abundant than males. The mating act, in many observed cases, required 1¼ to 3 minutes. One male has been observed to mate with as many as eight females in one day, but a female which has once mated will apparently refuse to mate again during her life. Females are usually mated the first day after emergence, but one isolated virgin female was mated when 55 days old, and two female offspring were reared from eggs subsequently laid.

HABITS.—*Thigmotropism vs. phototropism.* The studies have shown that this insect is positively thigmotropic, especially in the larval stage, but also to a less marked extent in the adult stage. The larvae congregate on the side of the cormel or leaf which lies against the side of the cage, where they feed until forced to go to other areas for want of food. In this narrow space the larvae, while feeding, frequently elevate the antennae until they touch the side of the cage above them. If the cormel or leaf is slowly moved away from the side of the cage until the insects are unable to reach the latter by elevating their antennae, they become disturbed and start running about. They will again congregate as before if the narrow space is restored. The insects behave in this manner whether in darkness or full sunlight, and a change in light intensity apparently does not disturb them. Larvae and adults, tested with regard to their reaction toward light by placing them on sheets of paper or on glass plates, with light coming from one direction, show no response either positively or negatively by direction of movement. On the basis of these observations the authors, therefore, believe that the large proportion of the insects, the larvae especially, remain in the leaf sheaths and other secluded places, until the food supply is exhausted, because of their positively thigmotropic reaction instead of the negative response to light. The sudden appearance of the insects on the foliage in the field may be correlated with the exhaustion of the food supply in the sheaths and the consequent moving of the insects to the exposed surfaces.

The response to heat above certain temperatures may be a factor in the daily behavior of the insects in the field.

Biting habits. Larvae and adults, crawling about on the authors' bare arms have sometimes produced pain by piercing the skin with their mouth parts.

Quarrelsome habits of larvae. Larvae usually feed quietly in numbers close beside one another, but frequently show quarrelsome traits. One larva may crawl partly upon another larva or pupa and then evidently inflict a pain-producing thrust with its mouth parts. The victim, if a larva, either returns the punishment or moves quickly away; if a pupa, it escapes by feeble effort. It is believed that the insect's habit of isolating itself from other larvae before pupating, and thus avoiding disturbance during the quiescent period, may be correlated with this quarrelsome habit. In the field this habit often carries the insect to the soil for pupation.

Sluggish nature and migration. In comparison with the activity of other thrips, such as *Frankliniella fusca* Hinds and *F. tritici* (Fitch), the gladiolus thrips is relatively sluggish. At room temperatures adults can be transferred by means of a camel's-hair brush without disturbing them more than to cause an occasional one to jump. At 80° F. or slightly above they become much more active and will jump and fly short distances. Their relative inactivity at ordinary temperatures is probably correlated with the small amount of migration occurring in the field before flowering time, after which they are forced to move in search of food.

In feeding on the corm, foliage, or flower parts, the thrips remove the contents of the surface cells, and such areas furnish no further food because the insects are unable to reach the cells beneath. In addition, suberization follows the feeding on the corms and this thickening of the area prevents further feeding.

SUMMARY.—The methods used in life-history studies on dormant cormels and in the insectary, and the egg and the two larval and two pupal stages, are briefly described.

The studies showed that 50° and 90° F. represent the approximate extremes of temperature for development, since no eggs hatched at either temperature, except a few at 90° F. and 100 per cent relative humidity. Eggs in corms exposed for 7 days or longer to a temperature of 33° F. failed to hatch. Larvae and pupae which developed slowly at 50° F. required average periods of 27 and 19 days, respectively, for development. At 60°, 70°, and 80° the insect developed normally but at accelerated rates with each higher temperature, since incubation required average periods of 10, 6.3, and 3.6 days; larval development 11.3, 6.9, and 3.4 days; pupal stages 10.3, 6.1, and 3.7 days; and the total development 31, 19, and 10.6 days, respectively.

Six generations, each requiring approximately 2 weeks, were reared in the insectary between June 10 and Sept. 6. Additional generations may

develop out of doors during one season in this area and breeding may be continuous on gladiolus foliage or corms at favorable temperatures. There is no evidence of seasonal hibernation. Adults lived as long as 76 days, but the average for both sexes ranged from 26 to 32 days in the insectary and 42 days at 70° F. in storage. A maximum of 204 eggs were laid by 1 female, but the averages were 117 and 130, respectively, in storage and insectary. Mating normally takes place and both sexes are represented among the offspring, but unmated females produce only male offspring.

The habits of the larvae of feeding in the leaf sheaths instead of on the exposed surface seem to be due to a positive thigmotropism rather than to negative phototropism. Larvae are often quarrelsome and evidently thrust others with their mouth parts, and this habit may be correlated with the isolation of the insects in the pupal stage. This thrips is relatively inactive at 70° F. or below and migrates very little in the field at this temperature.

PRELIMINARY REPORT ON THE CONTROL OF THE GLADIOLUS THRIPS ON CORMS IN STORAGE

By FLOYD F. SMITH and HENRY H. RICHARDSON,[1] *Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Results are given on tests with various corm treatments, including heat, fumigants, insecticidal and fungicidal dips, dusts, and smudges, with reference to the mortality of the gladiolus thrips (*Taeniothrips gladioli*) and the effect on the corms and succeeding growth.

An important source of field infestation of the gladiolus thrips, *Taeniothrips gladioli* M. & S., will be removed by an effective control measure applied to the corms before planting. The laboratory experiments with various materials as possible control measures, conducted during the winter of 1931–32, formed a basis for the preliminary recommendations for control made to the growers in the spring of 1932[2]. During this period 107 tests upon 8,741 gladiolus corms of five varieties and one mixture of varieties were conducted. The preliminary results herein reported should be considered primarily for the effectiveness

[1]The following New York gladiolus growers have aided in this investigation by their contribution of several types of gladiolus corms: Henry Breuss, Hamburg; W. W. Euler, Honeoye Falls; John W. Scott and John Charlton, Rochester.

[2]Weigel, C. A., Smith, Floyd F., and Richardson, Henry H. The Gladiolus Thrips. Florists' Exchange, Vol. 79 (No. 11), pp. 11, 40, 80B, March 12, 1932.

against the thrips and secondarily for the effect on the corm and the subsequent growth. The latter phase requires further study before the status of each treatment is definitely established.

METHODS.—The corms were well cured and the scales were dry at the time of treatment. The scales were left on the corms in all tests, because, except for the small grower, it is considered impractical to remove the scales before making the treatment. Infested corms were mixed with uninfested ones and stored in trays for from one to three weeks, when they would become infested. The tests with fumigants were made in a 200 cubic foot fumigation box at a temperature of 60° F., except as otherwise indicated. Fumigations with naphthalene flakes and insecticidal dusts were conducted by placing the material among the corms in an open tray or in a tied paper bag.

The insecticidal and fungicidal dips were used at a temperature of approximately 70°F. The tests with vapor heat were made in an air-conditioning cabinet and those with hot water were made in a thermostatically controlled treating tank as used for treatment of narcissus. The lots of corms which were given the treatment with one of the dips or with hot water were placed in thrips-tight cloth sacks before treatment and were then left in these sacks until dry enough for examination. Following treatment, each lot, after being placed in a tough paper bag and the top folded tightly to prevent entrance or exit of thrips, was stored in a cellar at a temperature of approximately 60° F. All of the treated stock was planted in plots on May 26, and records were made on the growth, flowering, and harvested crop of corms.

In recording the effectiveness of each treatment the old dried and broken thrips were discarded and only the recently killed insects were counted. This largely eliminated the possibility of counting thrips that died from starvation or old age. Although the dead and living larvae, pupae, and adults were recorded separately, the results are included in one figure in the present paper, since the various stages of the insect, except the egg, did not appear to differ greatly in susceptibility to treatment. Where the treatment was ineffective no extended counts were made.

The materials and treatments tested include the following fumigants, insecticidal dusts, insecticidal and fungicidal dips, and treatments by heat:

Calcium cyanide, a granular form containing 40 to 50 per cent calcium cyanide.
Ethylene dichloride-carbon tetrachloride mixture containing these chemicals in a ratio of 3 to 1 by volume.
Ethylene oxide.

Naphthalene flakes used at the rate of 1 ounce to 100 corms.

Pyrethrum smudge. A mixture of 12.5 per cent sodium nitrate and 87.5 per cent pyrethrum powder containing 1 per cent pyrethrins was burned in the chamber at the rate of one-half pound per 1,000 cubic feet.

Nicotine dust containing 1 per cent nicotine as nicotine sulfate in hydrated lime.

Pyrethrum dust containing 1 per cent pyrethrins.

Soap solution. A potassium-cocoanut oil soap was used.

Nicotine and soap solution containing nicotine sulfate 1–600 and 0.5 per cent of the above soap.

Pyrethrum extract and soap solution containing pyrethrins 1–5,000 and 0.5 per cent of the above soap.

Glue sizing in water.

Lye solution consisting of 1 pound of potassium hydroxide in 25 gallons of water.

Corrosive sublimate, 1 part mercuric chloride in 1,000 parts of water.

Calomel, 1 part of mercurous chloride suspended in 40 parts of water.

Ceresan, 1 part of this material, (containing 1.6 per cent ethyl mercury chloride) suspended in 200 parts of water.

Semesan, 1 part of this material (containing 30 per cent hydroxymercurichlorophenol) in 50 parts of water.

Carbolic acid, stock solution containing 88 per cent phenol, diluted as indicated.

Vapor heat.

Hot-water immersion.

The results of the tests are given in the table and in the discussion which follow.

TABLE 1. MORTALITY OF *Taeniothrips gladioli* ON DORMANT CORMS RESULTING FROM VARIOUS TREATMENTS OF THE CORMS

Treatment	Duration of treatment	Tests	Corms treated		Total insects examined	Ave. insects killed in tests
	Hours	*Number*	*Number*	*Variety*[1]	*Number*	*Per cent*
Calcium cyanide						
20 ounces[2]	1	2	50	c, f	520	100.0
5 ounces[2]	3	3	96	c, d, f	269	100.0
2½ ounces[2]	3	3	70	c, d, f	220	100.0
1¼ ounces[2]	3	7	275	a, c, f	1,694	99.9
½ ounce[2]	3	3	75	a	403	95.0
Ethylene dichloride-carbon tetrachloride mixture						
14 pounds[2]	4	1	25	f	104	92.3
14 pounds[2]	8	1	25	f	110	100.0
14 pounds[2]	12	1	25	f	151	100.0
14 pounds[2]	24	2	50	f	169	100.0
10.7 pounds[2]	24	1	40	f	60	100.0
Ethylene oxide						
1 pound[2]	24	1	25	c, d	([3])	
2 pounds[2]	24	1	25	c, d	23	100.0
4 pounds[2]	24	1	25	c, d	([3])	
Naphthalene flakes	*Days*					
In open trays	7	1	25	a	68	85.3
In paper bags	12	3	75	a, c	671	100.0
In paper bags	42	2	200	f	710	100.0

	Hours					
Pyrethrum smudge.	4	2	50	f	202	9.9
Nicotine sulfate dust	*Days*					
In open trays....	7	1	25	a	38	28.9
In paper bags....	2	1	25	a	40	35.0
Pyrethrum powder						
In open trays....	26	1	25	a	34	100.0
In paper bags....	26	1	25	a	106	28.3
Soap solution	*Hours*					
1–200 dilution...	1	1	25	f	45	84.4
1–100 dilution...	1	1	15	c, f	74	71.6
1–50 dilution....	1	1	25	c	83	71.1
Nicotine sulfate and soap solution....	1	1	25	f	40	85.0
Pyrethrum and soap solution.....	1	1	25	f	18	83.3
Glue solution						
1–40 dilution....	1	1	25	f	40	15.0
1–20 dilution....	1	1	25	f	41	22.0
Lye solution.....	8	1	25	b	13	30.8
Mercuric chloride..	1	2	50	f	420	97.6
	2	1	25	f	107	100.0
	3	9	225	a, b, c, f,	922	98.7
	8	1	5,000	a, c, d, e, f	(a)	
	Minutes					
Calomel.....	5	2	50	a	82	8.5
Ceresan.....	10	2	50	a	42	57.1
	30	1	25	f	(b)	
	Hours					
	1	1	25	f	62	100.0
Semesan.....	1	2	50	f	173	100.0
	2	1	25	f	107	100.0
	3	2	50	f	141	100.0
	7	2	50	a	166	100.0
Carbolic Acid						
1–80 dilution....	3	2	50	a, c	419	100.0
1–120 dilution...	3	4	100	a, b, c	259	100.0
1–160 dilution...	3	2	50	a, c	578	92.2
Vapor heat						
110°F. and 67 per cent relative humidity.....	1	1	25	f	35	17.1
	2	1	25	f	30	40.0
	3	1	25	f	63	55.6
110°.F and 90–95 per cent relative humidity	2	1	25	f	20	95.0
	4	1	25	f	38	100.0

TABLE 1. *Concluded*

Treatment	Duration of treatment *Minutes*	Tests *Number*	Corms treated *Number*	*Variety*[1]	Total insects examined *Number*	Average insects killed in tests *Per cent*
Hot water immersion						
108°F.	10	1	20	f	71	49.3
	20	1	20	f	42	45.2
110°F.	20	3	60	f	469	100.0
112°F.	20	3	60	f	476	100.0
	20	1	500	e	270	88.9
	30	1	500	e	209	100.0
114°F.	10	1	20	f	92	100.0
	20	2	35	f	344	100.0
116°F.	20	1	15	f	188	100.0
	Hours					
Checks immersed in water	3	3	75	a, c, f	457	42.9
	8	1	25	b	55	80.0
Untreated checks	([6])	3	45	a, c, f	1,422	0.6

[1]a—America, b—Crimson Glow, c—King, d—Los Angeles, e—President Harding, f—Primulinus mixed.
[2]Amount used per 1,000 cubic feet of space.
[3]Uninfested corms. [4]No counts made. [5]Ineffective, no counts made.
[6]No treatment.

DISCUSSION OF EXPERIMENTS.—*Effective treatments.* As will be observed in the preceding table, fumigation with calcium cyanide used at the rate of 1¼ ounces or more per 1,000 cubic feet of space was highly effective against the thrips in the larval, pupal and adult stages on corms with dry scales. In the 7 fumigations at the 1¼ ounce rate the kill of insects was complete except in 1 test where 2 larvae survived on 1 corm, apparently because of the protection given them by a large hard exudate from a scab-infected area. The gas seemed to penetrate the scales readily, since the insects were killed beneath as many as 6 layers of scales on corms in the bottom of trays covered by other corms to a depth of 4 inches. However, since the eggs within the corm tissue were apparently unaffected and hatched normally, a second fumigation was required in order to destroy infestation. Life history studies[3] show that the incubation period varies with the temperature and that the larval and egg stages are approximately equal in duration at any given temperature. With this information as a basis the second fumigation was made shortly after the first hatching larvae had entered the pupal stage, at which time the last eggs had hatched. This procedure resulted in a complete cleanup of the thrips in the experimental lots at the lethal

[3]Smith, Floyd F., and Nelson, R. H. Life history studies of the gladiolus thrips. Jour. Econ. Ent. Vol. 26, pp. 528–536, 1933.

dosages, 1¼ ounces or higher. Because of the variation of temperature in different parts of a storage house and because of the difficulty the average grower has in determining the time for making the second fumigation by observing the development of the insect, it is recommended that 3 fumigations at 10-day intervals be made regardless of the temperature. Since the dormant corms are tolerant of fumigation with high dosages of calcium cyanide, it is recommended that 5 ounces of the fumigant be used commercially per 1,000 cubic feet in order to allow for loss by leakage and by adsorption and still insure proper kill.

Fumigation with the ethylene dichloride-carbon tetrachloride mixture, originally recommended by Dustan[4] at the rate of 14 pounds per 1,000 cubic feet at a temperature of 70° F. for 24 hours, was effective at 60° F., even with as short an exposure as 8 hours at the 14-pound dosage. One test at 70° F., using 10.7 pounds per 1,000 cubic feet of space, was also effective. Since the eggs also are apparently killed by this treatment, only one fumigation is required. These tests indicate that shorter exposures and lower dosages than were originally recommended may be used to obtain a complete kill, but until these tests are checked further Dustan's recommendation should be followed. The proper dosage is an important point, since overdosages (56 pounds per 1,000 cubic feet) were found to result in severe injury to the corms. Small-scale growers, fumigating their stock in a 5-gallon lard can, have been observed to use 5 or 6 teaspoonfuls of the liquid, whereas 1 teaspoonful is the proper dosage at the 14-pound per 1,000 cubic feet rate. The injured corms, which are a complete loss, become soft, punky, and caramel colored and spotted with fungal growths, but retain their shape until they gradually dry and shrivel.

Naphthalene flakes when mixed among corms in paper bags at the rate of 1 ounce per 100 corms, killed all of the thrips after an exposure of 12 days or longer. The material acts as a fumigant, so a covering of paper or light canvas over the stacked trays in commercial houses seems necessary to concentrate the fumes and effect a complete kill. However, fumigation in a tight container, as a metal can, is not recommended because the corms sweat and sprout. Since the naphthalene is slowly volatile it acts for a considerable period of time even after the last eggs have hatched. No damage has been observed when dormant corms

[4]Dustan, Alan G. Recommendations for the Control of the Gladiolus Thrips in 1932, Canadian Department of Agriculture, D. F. C. & G. I. No. 102, Ottawa No. 35 (mimeographed circular). Also Dustan, A. G. and Bryce, P. I. Recommendations for the control of Gladiolus Thrips. The 1932 Canadian Gladiolus Annual 9: 61–64. 1932.

have been in direct contact with the material for as long as 4 months, which indicates that an overdosage will not be dangerous to the dormant stock. However, since naphthalene applied in the soil about the corms results in injury,[5] excess flakes should be shaken out and the corms aired for a short time before planting. Because of the high tolerance of the dormant corms to naphthalene, its low cost, ease of application, and effectiveness against the thrips, this material seems to be one of the best for use by the small-scale grower and also for the average large-scale grower who lacks special equipment for successfully using some of the other treatments.

As shown in the table, immersion in a 1–1,000 solution of mercuric chloride for periods of 1 to 3 hours, as used for disease control, gave a high but incomplete kill of the thrips. In the series of 9 tests at the 3-hour period the kill was complete in 4, but a few thrips survived in 5 tests. The survivors, however, were in sufficient numbers to renew the infestation. In 1 test where the stock was immersed for 8 hours and planted, no thrips appeared on the foliage or flowers during the growing season, which indicated the effectiveness of the treatment. However, because of the poor wetting qualities of this material it can not be relied upon to give a complete cleanup of the thrips. Commercial growers who have used it for as long as 17 hours as a dip obtained incomplete control on certain varieties. The survivors were usually found in the cavities about the buds at the top of the corm, where they were evidently protected in an air pocket.

Immersion of corms in a 2 per cent suspension of semesan (containing 30 per cent hydroxymercurichlorophenol) for 7 hours, as used for disease control, killed all thrips. Immersion periods as short as 1 hour also gave a complete kill, even though the insects beneath the scales in corm cavities were not wetted. Evidently a volatile substance which is given off by semesan has an insecticidal action against the thrips and is effective even after the corms have dried following treatment. The presence of this toxic volatile substance was demonstrated by bubbling air through a 2 per cent water suspension of semesan and passing it over corms infested with thrips, which died from 20 to 30 hours later. Thrips were killed by passing air over the dry powder into the chamber containing the insects. These tests indicate the possibility of killing the thrips, on corms, by a relatively short immersion in semesan which would allow some of the material to adhere to the scales, or by mixing the dry chemical with the corms in a dust carrier where the action would be as a fumi-

[5]Richardson, Henry H., and Nelson, R. H. 1932. Field control of the gladiolus thrips. Jour. Econ. Ent. Vol. 26, pp. 546–554, 1933.

gant similar to naphthalene. The effectiveness of such short treatments as the 1-hour dip has not been determined where used immediately before planting, but a 7-hour treatment was effective commercially. The scales on corms dipped in semesan became darkened and the outer leaves on the dormant buds of some corms were slightly injured and became brown and shriveled. The subsequent growth and flowers from such corms were not injured, however.

Commercial liquid carbolic acid (88 per cent phenol), when diluted with water at proportions of 1–80 and 1–120, killed the thrips on corms immersed for 3 hours, but was ineffective at a dilution of 1–160, as is shown in the table. This treatment did not visibly injure the dormant corms, but shoots and roots, starting into growth on the other corms, were injured. The mites *Tyroglyphus lintneri* Osborn were killed by all dilutions. Further work is required before conclusions will be drawn on the value of this treatment, particularly as to the tolerance by some varieties.

Vapor-heat treatments on small lots of corms indicate that a 4-hour heating at 110° F. and a high relative humidity will kill the thrips and the eggs. Lower humidity reduces the effectiveness of the treatment, as is indicated by the results in the table showing that 40 and 95 per cent of the thrips were killed by 2-hour treatments with relative humidities of 67 and 90 to 95 per cent, respectively.

Tests for control by hot-water immersion show that a 20-minute treatment at 110° to 116° F. is required to kill thrips on small lots of corms. However, larger quantities of corms will require longer treatment, as was shown in each of two tests where nearly a bushel of corms were treated in a burlap sack. A 30-minute treatment at 112° F. was required to penetrate the greater mass and effect a complete kill. No corm injury resulted from any of these treatments by vapor heat or hot-water immersion, but the corms were stimulated into earlier growth following planting in the greenhouse during the late winter, or into earlier sprouting when stored at 60° F. The heat treatments would be useful in the certification of stock for shipment, but their use will probably be limited because special equipment is required.

Ineffective treatments. The materials discussed under this heading either did not kill the thrips or they injured the corms under the conditions of the experiments. Possibly modifications of some of these treatments will make them effective.

Fumigation with ethylene oxide at the dosages used killed the corms as well as the thrips.

Pyrethrum smudge was ineffective against the thrips beneath the

scales. Heavy applications of nicotine and pyrethrum dusts to corms in paper bags were not effective against the thrips beneath the scales. Immersing the corms for one hour in solutions of soap, nicotine sulphate and soap, pyrethrum and soap, glue, or potassium hydroxide, or in water for periods up to 8 hours were ineffective as control. None of these treatments injured the corms.

Immersing infested corms for 10 minutes in ceresan or for 5 minutes in calomel, as is done in disease control, was not effective against the thrips. A 30-minute dip in ceresan was ineffective, but in one test where a 1-hour immersion was used all thrips were dead when examined 6 weeks later. The results of this test are questioned, since the thrips may have died from other causes. No corm injury resulted from any of these tests.

Effect on the growth following treatment. From the past year's work the drawing of definite conclusions on the effect of the various corm treatments upon the succeeding crop is complicated for the following reasons: (1) The treatments were made at various times during the winter from December to March. (2) The corms were not all injured to the same extent by the feeding of the thrips. (3) The soil in which the lots were planted varied in its composition in different areas. However, it was apparent that, except for the stimulation produced by heat treatments or by fumigation with the ethylene dichloride-carbon tetrachloride mixture and the retardation produced by mercuric chloride or by semesan dips, no marked effect on the growth, flowering, and corm production resulted when no effects were visible on the corms before planting.

Residual action of corm treatments. An important point in the practical use of a thrips control on the corms is the matter of reinfestation following treatment. Fumigation with calcium cyanide or ethylene dichloride-carbon tetrachloride and the treatments with vapor heat or hot water were effective against the thrips present at the time, but did not have residual action and prevent later reinfestation. The treatment with mercuric chloride gave only partial protection in laboratory tests. The efficiency of the phenol dip in this respect has not been tested. Naphthalene flakes and semesan, because of the persistence of the materials on the corms, where they act as slow-acting fumigants, give the most prolonged protection, but the extent of this protection requires further study. If the treatment finally selected does not possess a residual effect and give this protection, precautions must be taken to prevent the thrips from gaining access to the treated stock from the untreated. These precautions should take cognizance of the fact that the thrips can be carried on the clothing, among hairs on the bare arms, and on trays or

other utensils, and that they will move about among the corms in storage.

CONCLUSIONS.—Based on the results of these preliminary experiments, 8 of the 19 materials or treatments tested in the laboratory for the control of thrips on unscaled gladiolus corms in storage showed a high degree of efficiency by killing the thrips and not seriously injuring the corms. Because calcium cyanide kills all stages except the eggs, a second fumigation is required after the eggs have hatched. Three fumigations at 10-day intervals, using a dosage of 5 ounces per 1,000 cubic feet, are recommended. A 24-hour fumigation using 14 pounds of ethylene dichloride-carbon tetrachloride mixture per 1,000 cubic feet killed all stages of the insect and only one treatment was required. The effectiveness of 8 and 12 hour exposures was indicated in limited tests, but at present these shorter periods are not recommended. Treatments by vapor heat for 4 hours at a temperature of 110° F. and 95 per cent relative humidity, or by immersion in hot water for 20 minutes at temperatures of 110° to 116° F., killed the egg as well as the other stages in small lots of corms. When larger lots are treated, the treatment is necessarily longer. These four treatments do not have residual effects to prevent later reinfestation. A 3-hour immersion of corms in a 1–80 or 1–120 dilution of phenol solution killed all the thrips, but the status of this material requires further study. Immersion in a 1–1,000 dilution of mercuric chloride for 3 hours resulted in a high but incomplete kill of the thrips and only partial protection following treatment. Application of 1 ounce of naphthalene flakes to 100 corms or an immersion for 1 to 7 hours in a 1–50 semesan suspension gave a complete kill of the thrips, and since these materials function as slow-acting fumigants the corms are protected from reinfestation for a longer time than with any of the other treatments.

The heat treatments and fumigation with ethylene dichloride-carbon tetrachloride mixture hastened the breaking of dormancy of corms when used as recommended. Increasing the dosage of the latter to 56 pounds per 1,000 cubic feet injured the corms, so the use of this material at higher rates than 14 pounds per 1,000 cubic feet or 1 teaspoonful to a 5-gallon receptacle is inadvisable. Treatment in mercuric chloride or in semesan delayed the starting of growth after planting, but the effects were not permanent. The evidence indicated that none of the treatments otherwise affected the resulting growth, flowering, or corm production where the corms were not visibly affected at planting time.

FIELD CONTROL OF THE GLADIOLUS THRIPS (*TAENIOTHRIPS GLADIOLI* M. & S.)

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ABSTRACT

Paris green-brown sugar spray, a lead arsenate combination spray, and nicotine tannate, as well as three other sprays, were tested, each on 15 small plots during the 1932 season (8 applications at weekly intervals). Each small plot contained two red varieties of gladiolus, Crimson Glow and Brilliant, which had been uniformly infested with the gladiolus thrips. Paris green-brown sugar spray was by far the most efficient, not only in controlling the thrips, but also in reducing thrips injury to the flowers. Data on the number and size of flowers, foliage development, and number and size of corms harvested indicated that the pine tar oil-nicotine spray, as well as the nicotine sulfate-soap spray, especially the latter, had a distinctly injurious effect on the plants. Of the five other insecticides that were tested on a smaller scale at this same field, the white oil-nicotine spray was most effective, but this did not approach the Paris green-brown sugar spray in efficiency. A total of 14 insecticides, including all the above, were tested at another field for their effect on uninfested gladiolus (variety Alice Tiplady). Only the nicotine sulfate-soap spray had any distinctly injurious effect (as evidenced by flower and corm production). Preliminary experiments indicated that one or two applications of naphthalene, paradichlorobenzene, tobacco dust, carbon disulphide emulsion, or ethylene dichloride emulsion, applied to the soil just after planting corms, would not be effective for controlling the thrips. Naphthalene and paradichlorobenzene (especially the latter) greatly retarded the growth of the plants and evidently caused some reduction in the corm and flower production. The gladiolus thrips does not appear to move about much during the growing and early blooming season, but considerable numbers do migrate, apparently close to the ground, after the flowers are cut. Muslin barriers 3 feet high erected between treated plots were apparently effective up through flowering time in reducing any slight movement of thrips from one plot to another. Observations of the predator *Orius insidiosus* (Say) indicated that it can kill as many as 30 thrips per day and that it might reduce thrips populations in small isolated plots.

No matter how effective the corm treatments for gladiolus thrips control may be, it will apparently always be necessary to have some measures available for controlling this thrips on the growing plant in the field. This would be of benefit especially to the grower who has failed to apply effective corm treatments and to the home gardener who accidentally plants infested corms, as well as to growers in such sections as California and Florida, where adjacent fields of gladiolus are brought into bloom during every month of the year.

The experiments reported here were made to determine the effective-

[1]The authors wish to acknowledge with thanks the aid given by Drs. C. A. Weigel and Floyd F. Smith, Mr. A. T. Grimes, and Dr. J. W. Bulger at various times during the progress of the experiments.

ness against the gladiolus thrips of a number of sprays and dusts applied eight times at weekly intervals during the growing season. Field tests were also made to ascertain the tolerance of the plant to the spray when no gladiolus thrips were present. The results of a few preliminary experiments with soil insecticides, as well as some notes on thrips migration, are also reported.

INSECTICIDES TESTED.— The following insecticides were used:

Paris green-brown sugar[2]

Paris green	1	ounce
Brown sugar	2	pounds
Water	3	gallons

Nicotine tannate

Nicotine solution (50 per cent)	½	pint
Tannic acid[4]	1	pound
Ferric oxide-skim milk	1	pound
Water	50	gallons

Pine tar oil-nicotine

Saponified pine tar oil[5]	2	quarts
Nicotine sulfate (40 per cent)	6	fluid ozs.
Water	50	gallons

Pyrethrum-soap

Pyrethrum extract[7]	1	fluid oz.
Soap (40 per cent concentrate)[6]	1½	fluid ozs.
Water	1	gallon

"White" oil-nicotine

Oil concentrate[9]	12	fluid ozs.
Nicotine sulfate (40 per cent)	1	fluid oz.
Water	8	gallons

Soap

Soap (40 per cent concentrate)[6]	1½	fluid ozs.
Water	1	gallon

Nicotine dust

Hydrated lime	95	pounds
Nicotine sulfate (40 per cent)	5	pounds

Lead arsenate combination[3]

Lead arsenate	1½	pounds
Nicotine sulfate (40 per cent)	1	pint
Waste sulfite liquor	1½	quarts
Water	50	gallons

Bordeaux-nicotine

Copper sulfate	4	pounds
Hydrated lime	6	pounds
Nicotine solution (50 per cent)	12	fluid ozs.
Water	50	gallons

Nicotine sulfate-soap

Soap (40 per cent concentrate)[6]	5	pints
Nicotine sulfate (40 per cent)	11	fluid ozs.
Water	50	gallons

Derris-soap

Derris extract[8]	2	fluid ozs.
Soap (40 per cent con centrate)[6]	9	fluid ozs.
Water	6	gallons

Paris green-nicotine

Paris green	1	ounce
Nicotine sulfate (40 per cent)	½	fluid oz.
Water	3	gallons

Sulfur dust

Wettable flotation sulfur	80	per cent
Inert material	20	per cent

Pyrethrum dust

A pyrethrum powder-china clay mixture plus pyrethrum extract to make the mixture contain 0.8 per cent pyrethrins.

[2]The formula used here is a modification (only about one-half the quantity of Paris green is used) of that recommended by A. G. Dustan, of the Canadian Department of Agriculture, for gladiolus thrips control. Dustan, A. G., "The Gladiolus Thrips and its Control," Canadian Dept. of Agriculture, D. F. C. & G. I. mimeographed circular

ARRANGEMENT OF EXPERIMENTS.—Small plots were used entirely throughout the tests. The field control experiments were made at Takoma Park, Md. Six sprays were tested on a total of 90 small plots each containing 40 infested gladiolus of the variety Crimson Glow and 25 of the variety Brilliant. Untreated check plots were laid out 100 feet away from the treated ones. Five other sprays and dusts were tested on a small scale at this same field, a total of 15 small plots being used. All the above sprays and dusts as well as three others were tested for their effect on uninfested plants at the Arlington Experimental Farm in Virginia. Here 57 small plots were planted, each containing 20 uninfested gladiolus, variety Alice Tiplady. Each insecticide was tested on 3 small plots; 15 small plots distributed evenly throughout the field were used as checks.

THRIPS CONTROL EXPERIMENTS.—Two red varieties of gladiolus, Crimson Glow and Brilliant, were chosen for the thrips control experiments because the thrips injury would show very strikingly on these. The corms of No. 2 size were uniformly infested with the gladiolus thrips, so that by the time of planting from 5 to 15 active thrips in various stages could be found on any one corm. The Crimson Glow were more heavily infested than the Brilliant; apparently the tighter husk of the Brilliant might account for this. The 15 small plots used in each treatment were planted so that when comparisons of results were desired each small plot could be paired directly with a similar plot in another treatment.

The corms were all planted on May 26. They sprouted normally and within 2 weeks the shoots were 3 to 4 inches above ground and quite

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No. 101, p. 4, 1931; and Dustan, A. G., and Bryce, P. I., "Recommendations for the control of Gladiolus Thrips," The 1932 Canadian Gladiolus Annual 9:61–64.

[3]This is a formula recommended by E. A. Herr in "The Gladiolus Thrips," Ohio Agricultural Experiment Station, 1931, mimeographed circular. Also in the "Report of the 11th Annual Conference of North Central States Entomologists," Wooster, Ohio, March 3–4, 1932, pp. 32–34, mimeographed.

[4]Tannic acid obtained from Chinese galls was used. Care was taken that all tannic acid was in solution before adding nicotine.

[5]Saponified pine tar oil, containing 56 per cent of a pine tar oil, boiling range 100–240°C., specific gravity 0.900 to 0.910 at 15.5°C.; saponified with caustic soda and rosin.

[6]Soap. A potassium-cocoanut oil soap.

[7]Pyrethrum extract. Alcoholic extract containing 1.8 grams pyrethrins per 100 cc.

[8]Derris extract. An acetone extract containing 2.3 grams of rotenone per 100 cc. as well as other derris extractives.

[9]Oil concentrate, containing 83 per cent highly refined petroleum "white" oil by volume, with a casein emulsifier.

uniformly infested with thrips. The spray and dust applications were started June 14 and were made weekly thereafter. When rain interfered, the applications were postponed until the next sunny day. Sprays were applied with a knapsack sprayer at approximately 60 pounds pressure. Dusts were applied with a hand duster of the pump type. A total of 8 applications were made as follows: June 14, 21, and 29, July 5, 12, 18, and 26, and August 4. About 6 weeks after planting, muslin barriers (3 feet in height) were erected between plots to prevent movement of the thrips from one plot to another. By the time of the last spray application a few flowers of the Brilliant variety had started to bloom. Flower cutting was commenced August 9 and continued thereafter at 2-day intervals (in one case 3 days) until August 24, at which time the majority of the flowers had bloomed. Cuttings were also made on September 1, 10, and 14. Flowers were graded by the length of the spike and size of the individual florets into the categories: Small (No. 1), medium (No. 2), and large (No. 3). Owing to natural varietal differences, Crimson Glow flowers were distinctly larger than those of the Brilliant. Flowers were graded as to thrips injury as follows:

Grade 1—No thrips injury, highest class of salability.
Grade 2—Very slight injury, 1 or 2 white specks where thrips had fed on one floret. Second class salability.
Grade 3—Slight injury, margins of 1 or 2 petals of 1 or 2 florets crimped from thrips feeding. Few white flecked areas on petals themselves. Third class salability.
Grade 4—Moderate injury, noticeable streaking of petals where thrips had fed. Numbers of petals with crimped and curled margins. Not salable.
Grade 5—Severe injury, florets were distorted and did not open normally. Considerable crimping of margins of petals and large streaked areas on petals and sepals. Not salable.
Grade 6—Very severe injury, flowers so badly damaged that they did not open. Some flower spikes dried before color showed on bud sheath. Not salable.

On August 19, 50 florets of each variety (the 2nd floret above the last fully opened floret) were collected in groups of 10 from each treatment. Each group of 10 was collected at random from each of five sections in the treatment (each section consisting of 3 small plots). The florets were later examined under binocular microscopes and counts were made of the number of thrips present. Table 1 shows the results of these thrips counts and summarizes the records on thrips injury to the flowers.

In judging the effectiveness of the sprays, emphasis should be placed on the results with the Crimson Glow, as this variety without doubt was

more heavily infested and the sprays were thus subjected to a more severe test of efficiency. It is evident from the results, as shown in Table 1, that the Paris green-brown sugar spray was by far the most

TABLE 1. EFFECTIVENESS OF VARIOUS SPRAYS[1] IN CONTROLLING THE GLADIOLUS THRIPS AND IN REDUCING THRIPS INJURY TO FLOWERS, TAKOMA PARK, MD. EACH SPRAY WAS TESTED ON 15 PLOTS, EACH PLOT CONTAINING 40 PLANTS OF CRIMSON GLOW AND 25 PLANTS OF BRILLIANT

Sprays	Total thrips found in florets[2]	Average thrips per floret	Total flowers harvested	Grade 1 flowers	Total salable[3] flowers	Total unsalable[4] flowers
	Number	*Number*	*Number*	*Per cent*	*Per cent*	*Per cent*
I. Results with Crimson Glow						
Paris green-brown sugar	31	0.6	538	72.6	89.8	10.2
Lead arsenate combination	116	2.3	533	29.2	68.5	31.5
Nicotine tannate	183	3.7	498	23.6	57.6	42.4
Bordeaux-nicotine	361	9.0	522	0.8	10.8	89.2
Nicotine sulfate-soap	685	13.7	333	0.0	3.3	96.7
Pine tar oil-nicotine	1,000	20.0	471	0.0	0.4	99.6
II. Results with Brilliant						
Paris green-brown sugar	11	0.5	323	82.3	95.5	4.5
Lead arsenate combination	26	1.0	333	66.9	93.0	7.0
Nicotine tannate	35	1.4	312	65.0	91.2	8.8
Bordeaux-nicotine	143	5.8	327	7.3	62.3	37.7
Nicotine sulfate-soap	273	11.9	293	0.3	36.5	63.5
Pine tar oil-nicotine	386	15.4	310	0.3	35.4	64.6

[1]The untreated check plots were located some distance away from the treated plots and very low thrips infestations were present. The predator *Orius insidiosus* (Say) was present in large numbers. Laboratory studies by the junior author have shown that this insect can kill as many as 30 thrips per day. The large numbers of Orius in the checks might account for the small numbers of thrips present. Very few if any Orius could be found in the treated plots. In view of these complicating factors, as well as differences in the soil, the data taken from the check plots were of no comparative value for determining the effectiveness of the sprays, and comparisons are limited to the results obtained among the various sprayed plots themselves.

[2]All of the 50 florets of Crimson Glow collected from each treatment were examined, except those from the Bordeaux-nicotine test, of which 40 were examined. In the Brilliant from 22 to 25 from each treatment were examined.

[3]Salable flowers included grades 1, 2, and 3.

[4]Unsalable flowers included grades 4, 5, and 6.

efficient not only as regards thrips control but also as to the production of first class flowers and the total of salable flowers. The other materials are shown in the order of their efficiency. The results were consistently the same on both varieties of gladiolus. There is apparently a direct (positive) correlation between the numbers of thrips present and the amount of injury done to the flowers.

Shortly after blooming time, notes were made on the average height and condition of the foliage, the thrips injury to the foliage, and the presence or absence of spray deposits. The corms were dug October 11

and 12, placed in trays, cleaned of old corms November 4, and counted and weighed November 11. The data from these examinations are summarized in Table 2.

TABLE 2. FLOWER PRODUCTION, FOLIAGE DEVELOPMENT, AND WEIGHT OF CORMS HARVESTED ON INFESTED GLADIOLUS TREATED WITH VARIOUS SPRAYS, TAKOMA PARK, MD.

Spray	Average number flowers per plot	Average size of flowers[1]	Average height of foliage at maturity	Average number of corms harvested per plot	Average weight of corms harvested per plot	Average weight of corms harvested
			Inches		*Grams*	*Grams*
I. Results with Crimson Glow (40 Corms in Each Plot, 15 Plots per Treatment)						
Paris green-brown sugar	35.9	2.604	27	36.7	1,064	28.99
Lead arsenate combination	35.5	2.285	28	36.6	962	26.28
Nicotine tannate	33.2	2.367	27	37.0	970	26.21
Bordeaux-nicotine	34.8	2.068	27.5	36.1	891	24.70
Nicotine sulfate-soap	22.2	1.744	20	30.9	491	15.88
Pine tar oil-nicotine	31.4	1.919	24	35.4	816	23.05
II. Results with Brilliant (25 Corms in Each Plot, 15 Plots per Treatment)						
Paris green-brown sugar	21.5	2.761	20.5	22.5	423	18.81
Lead arsenate combination	22.2	2.642	20.5	24.3	463	19.07
Nicotine tannate	20.8	2.580	20.5	24.4	471	19.29
Bordeaux-nicotine	21.8	2.333	20.5	24.0	407	16.97
Nicotine sulfate-soap	19.5	2.098	14.5	22.1	308	13.95
Pine tar oil-nicotine	20.7	2.274	17.5	23.4	407	17.41

[1]Small flower = 1.000, medium flower = 2.000, large flower = 3.000.

The data presented in Table 2 indicate that the first four sprays had little effect on the plant. The pine tar oil spray plots and the nicotine sulfate-soap spray plots are distinctly lower as regards size of flower and height of foliage. Nicotine sulfate-soap plots were also significantly lower as regards the production in number and size of corms and number of flowers. It appears that these two sprays were not only ineffective in controlling the thrips but they also (especially nicotine sulfate-soap) exerted an injurious effect on the plant. Whether this was a direct spray injury or whether the spray provided a favorable environment for the development of disease is a question. The fact remains that the corms harvested from these plots were considerably distorted, had poor husks, and were distinctly more diseased.[10] (Scab *Bacterium marginatum* McCulloch.)

Spray injury and spray deposits. Paris green-brown sugar spray apparently causes some injury to the growing foliage, for usually 2 or 3

[10]The authors are indebted to Miss Lucia McCulloch, of the United States Bureau of Plant Industry, for examination of the corms and identification of the organism.

of the lowest leaves were entirely dead, and a few dead spots were scattered over the upper leaves when the plant matured. Apparently the injury done by the Paris green-brown sugar spray was only of a temporary nature and of no great importance to the final number and size of flowers produced, to the height and vigor of the foliage, and to the corm production, for with the most heavily infested variety (Crimson Glow) the Paris green-brown sugar plots led all others in these respects. The sticky residue left by this spray is easily washed off by rain. In future tests it might be found possible to reduce the number of Paris green-brown sugar applications by spraying at greater intervals and renewing the application only after rains have washed off the spray residue.

Both the lead arsenate spray and the nicotine tannate spray left insoluble residues that might reduce the attractiveness of the foliage.

INSECTICIDES TESTED ON SMALLER SCALE.—The same procedure as used with the large-scale tests was followed with these experiments. The data on thrips population and thrips injury to flowers have been gathered and are summarized in Table 3.[11]

TABLE 3. RESULTS OF SMALL-SCALE THRIPS CONTROL TESTS, TAKOMA PARK, MD. (EACH SPRAY WAS TESTED ON 3 PLOTS, EACH PLOT CONTAINING 40 PLANTS OF CRIMSON GLOW AND 25 PLANTS OF BRILLIANT)

Insecticide	Crimson Glow			Brilliant[1]	
	Average thrips population per floret	Grade 1 flowers	Total salable flowers[2]	Grade 1 flowers	Total salable flowers[2]
	Number	*Per cent*	*Per cent*	*Per cent*	*Per cent*
White oil-nicotine	2.4	17.5	67.1	36	94.0
Derris-soap	3.2	7.8	37.7	24.4	73.2
Pyrethrum-soap	6.7	4.5	15.8	10.5	71.0
Sulfur dust	18.7	3.4	12.4	6.2	43.4

[1]No thrips population counts were made on the Brilliant. As in other Brilliants examined at this same field, however, the thrips populations were probably very much lower than those in the Crimson Glow.
[2]Salable flowers included grades 1, 2, and 3.

The most effective of these treatments appears to be the white oil-nicotine sulfate combination, though this spray does not compare favorably in efficiency with the Paris green-brown sugar spray. It is apparently about the equal of the lead arsenate combination spray. Derris extract-soap and pyrethrum extract-soap sprays follow in the order named. Sulfur dust was by far the least effective.

[11]These same plots had previously been used for unsuccessful soil insecticide tests. Hence the data on flower and foliage development and on corm production could not be used in judging the sprays and dusts.

TOLERANCE TESTS ON UNINFESTED PLANTS.—For these tests the gladiolus corms (variety Alice Tiplady) were planted May 6, 1932. Spray and dust treatments were applied (at weekly intervals if rain did not interfere) as follows: June 2, 8, 17, and 23, July 1, 7, 15, and 22. Flowers were cut and graded as to size on July 29 and August 16 and 24. The corms were harvested October 21, placed in trays, cleaned November 4, and counted and weighed November 11. The results are summarized in Table 4.[12]

TABLE 4. RESULTS OF PLANT TOLERANCE TESTS ON UNINFESTED GLADIOLUS AT THE ARLINGTON EXPERIMENTAL FARM IN VIRGINIA. (EACH INSECTICIDE WAS TESTED ON 3 PLOTS EACH PLOT CONTAINING 20 PLANTS OF GLADIOLUS, VARIETY ALICE TIPLADY)

Insecticide	Treated plots			Check plots		
	Average number of flowers per plot	Average size of flowers[1]	Average weight of corms per plot	Average number of flowers per plot	Average size of flowers[1]	Average weight of corms per plot
			Grams			*Grams*
Paris green-brown sugar	20.0	1.82	870	21.3	2.19	940
Lead arsenate combination	14.3	1.79	547	14.6	1.98	590
Nicotine tannate	21.3	2.28	910	23.6	2.31	1,047
Bordeaux-nicotine	14.3	2.00	557	13.3	1.78	570
Nicotine sulfate-soap	11.0	1.39	523	16.0	1.75	773
Pine tar oil-nicotine	19.3	2.05	973	21.6	2.25	1,073
Paris green-nicotine	16.0	2.06	600	13.6	2.22	660
Pyrethrum-soap	14.0	1.71	617	15.6	2.09	713
Derris-soap	9.6	1.90	630	15.6	1.77	630
Soap	12.3	1.89	673	12.6	1.97	540
White oil-nicotine	13.3	1.70	590	13.6	2.00	640
Pyrethrum dust	18.0	1.98	843	17.0	2.18	697
Sulfur dust	10.3	1.55	497	13.0	1.77	630
Nicotine dust	21.0	2.17	983	16.0	1.94	800

[1]Small flower = 1.00, medium flower = 2.00, large flower = 3.00.

The plots given the various treatments had been scattered at random over this field so that no one treatment was repeated in the 4 long rows. As the season progressed, however, it was noted that the soil conditions, as evidenced by the growth of the plants, varied greatly over the field. Those plants near the east end were much more vigorous and produced more flowers and greater numbers of larger corms. Hence direct comparisons among the treated plots can not be made. However, as each treated plot had an untreated check very close by (there were 15 untreated check plots), direct comparison could be made between these.

[12]Early in the growing season a considerable infestation of the tobacco thrips, *Frankliniella fusca* Hinds, developed in this experimental field. On June 8 the checks were also sprayed in order to prevent any thrips injury on the checks from interfering with the comparative results. However, the following week the tobacco thrips started to migrate out to tobacco and other plants near by and no further sprays were applied to the checks.

The nicotine sulfate-soap plots were the only ones in which the production of both flowers and corms was significantly lower than that of the untreated check. The indications are that none of the other sprays had any distinctly injurious effect on the plants. This result with the nicotine sulfate-soap spray corroborates what was found in the thrips control tests on the Crimson Glow and Brilliant varieties.

Soil Insecticide Tests.—A number of soil insecticides, applied shortly after planting infested corms, have been tested to ascertain whether it would be possible to control thrips in this way. Naphthalene flakes (2 ounces to 50 corms), paradichlorobenzene crystals (1 ounce to 50 corms), tobacco dust (1 pound to 50 corms), carbon disulphide (1–750 emulsion, 1 gallon to 50 corms), and ethylene dichloride (1–750 emulsion, 1 gallon to 50 corms) were tested on corms of Crimson Glow and Brilliant. The treatments were applied to the soil from 1 to 1½ inches above the corms the day after planting. More soil was then drawn in over the row. Some plots were given a second application 11 days after planting.

None of these chemicals with either one or two treatments was completely effective against the thrips. There was some doubt concerning the results in the plots in which two applications of naphthalene or ethylene dichloride were made. In addition to being ineffective, both naphthalene and paradichlorobenzene (especially the latter) produced a definite retardation in growth and evidently lowered the flower production and weight of corms, especially where two treatments were applied.

Studies on Migration of the Thrips.—Field observations indicate that the gladiolus thrips migrate very little during the growing and early blooming season of the gladiolus. Following the cutting of the flowers and maturing of foliage, the thrips, especially on heavily infested plants, move away apparently in search of new plants. This was brought out by studies where sticky fly papers were set up around various plots at from 1 to 3 feet above ground. Of a total of 1,012 thrips caught, 82.3 per cent were taken on papers from 0 to 1 foot above ground and 17.7 per cent from 2 to 3 feet above ground. These figures indicate that large numbers of this species of thrips migrate just above ground. Apparently the muslin barriers which were erected at midseason between the plots of different treatments were effective in stopping what little migration occurred up to flowering time, for the thrips population counts were quite consistent throughout a plot and were not higher near the separating barrier, although the thrips populations differed greatly in adjacent plots, as indicated in Table 1.

GREENHOUSE AND FIELD TESTS FOR THE CONTROL OF THE GLADIOLUS THRIPS)[1] (*TAENIOTHRIPS GLADIOLI* M. & S.)

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ABSTRACT

The gladiolus thrips probably does not pass the winter in the fields in large numbers in New Jersey. The destruction of waste corms, volunteer plants and other rubbish in and surrounding the field is advisable. The destruction of the thrips on corms in storage may be accomplished by a number of methods such as dipping in mercury compounds, nicotine solutions, fumigating with naphthalene, nicotine dust, pyrethrum dust, calcium cyanide and other materials. In controlling the thrips on the foliage it is necessary to start early, and spray frequently. Dusts containing pyrethrins or rotenone, applied either as dusts or as wet sprays, were more effective than liquid sprays containing either pyrethrins or rotenone. The brown sugar, Paris green and water spray is said to be very effective and considerably cheaper than many other sprays.

The gladiolus thrips was first recorded as injuring gladiolus the summer of 1930. It did extensive damage to plants in 1931 and was even more abundant and injurious the summer of 1932. Preliminary field tests conducted in August 1931 on gladiolus plants heavily infested with thrips indicated the difficulty of controlling this pest after an infestation had become established. Accordingly, arrangements were made to do some experimental work upon controlling the thrips on the corms in the winter and upon plants growing in the greenhouse. The work reported in this paper gives the results of greenhouse experiments the winter and spring of 1932 and some of the field tests the summer of 1932.

The successful control of the thrips may properly be divided into three phases. First, the cleaning up and destruction of all weeds, rubbish, old gladiolus corms and other material in and near the gladiolus field in which the thrips might hibernate during the winter; second, the destruction of the thrips carried into storage on the corms in the fall, thus preventing injury to the corms as well as infesting the plants in the spring after planting and; third, the control of the thrips on the foliage and bloom of growing plants.

If clean up measures are not practiced it is possible that the gladiolus thrips may winter over in the field, and for plants to become infested from these thrips the following year. The greatest source of infestation in the spring is, no doubt, from thrips wintering over on the corms in

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

storage and carried to the field when the corms are planted. Therefore, the importance of eliminating the thrips on the corms.

TESTS IN CONTROLLING THE THRIPS ON THE CORMS.—Information from several articles published in the summer and fall of 1931, indicated that there were several procedures which might be followed to rid the corms of thrips. Some of these were fumigating with one of several materials such as calcium cyanide, carbon bi-sulphide, ethylene dichloride 75% and carbon tetrachloride 25%, dipping corms in hot water, a bichloride of mercury solution, or in nicotine or pyrethrum spray solutions, and the storage of the corms at temperatures below 40°F. to prevent development of the thrips.

Late in December 1931, the writer started experiments to determine the efficiency of several methods of destroying the thrips on the corms. The tests were conducted on two varieties of gladiolus, namely Ming Toy, and Alice Tiplady. The corms had been stored in a warm cellar after digging and cleaning and at the time of starting the experiments, were heavily and rather uniformly infested with all stages of the gladiolus thrips. Fifty corms of each variety were used in each test. They were placed in 16 pound heavy paper bags, two bags thick to prevent tearing, and the treatment either made in the bag or, in case of those which were dipped in hot water or insecticide solution, the corms were placed in the bags after drying. The bags were closed by folding over the tops several times and clipping, leaving the air space at approximately ¼ cubic foot. The dosages for the fumigating materials and dustings were figured on the basis of ¼ cubic foot air space. The 50 bulbs filled approximately ⅓ of this space.

The Ming Toy corms were treated on December 16, 1931 and the first examination to determine the number of live thrips were made from December 19 to 22. A second examination of the corms were made on January 28 and 29, 1932. The Alice Tiplady corms were treated December 23, 1931 and the first examination made December 26 and 28. The second examination of these corms was made on January 30 and 31, 1932. Ten corms were carefully examined each time under the microscope and accurate counts made of the adult thrips and the young thrips. The first examination was made to determine the kill of the thrips immediately after treatment and the second examination approximately a month after the treatment to determine the extent of the reinfestation from eggs which might not have been killed. The bags containing the treated corms were kept in the laboratory at a temperature of about 68 to 70° F. in order that development might occur and the results of the treatment obtained in a shorter time.

The materials used in the treatment and the results obtained are given in the accompanying table.

An examination of 15 Ming Toy corms made December 16, before treatment, showed 236 adult thrips and 52 young, a total of 288 thrips or an average of 18 thrips per corm. Twenty untreated Alice Tiplady corms examined December 23, had an infestation of 93 adult thrips and 224 nymphs, a total of 317 thrips, and an average of 15 thrips per corm. The smallest number of thrips found on a single corm was 4 and the largest 53.

TABLE 1. TABLE SHOWING THE NUMBER OF GLADIOLUS THRIPS FOUND ON 10 TREATED CORMS 3 TO 4 DAYS AFTER TREATMENT AND ONE MONTH AFTER TREATMENT

Material used	Amount	Time of treatment	Ming Toy 1st exam.	Ming Toy 2nd exam.	Alice Tiplady 1st exam.	Alice Tiplady 2nd exam.
1. Calcyanide	0.7 gms.	5 hrs.	0	92	0	23
2. Calcyanide	0.7 gms.	10 hrs.	1	11	0	21
3. Calcyanide	1.5 gms.	5 hrs.	0	42	0	0
4. Calcyanide	1.5 gms.	10 hrs.	0	10	0	1
5. Carbon bisulfide	1.0 cc.	5 hrs.	60	94	2	17
6. Carbon bisulfide	1.0 cc.	10 hrs.	73	97	21	18
7. Carbon bisulfide	2.0 cc.	5 hrs.	46	98	104	25
8. Carbon bisulfide	2.0 cc.	10 hrs.	45	149	99	9
9. Paradichlorobenzene	0.5 gms.		7	135	57	10
10. Paradichlorobenzene	1.0 gms.		6	102	12	31
11. Paradichlorobenzene	2.0 gms.		0	83	1	31
12. Naphthalene	0.5 gms.		16	197	2	11
13. Naphthalene	1.0 gms.		9	102	1	1
14. Naphthalene	2.0 gms.		0	0	0	0
15. 2% Free nicotine dust	1.0 oz.		0	0	0	0
16. 2% Free nicotine dust	2.0 oz.		10	0	0	0
17. 2% Free nicotine dust	4.0 oz.		4	0	0	0
18. Black Arrow dust	1.0 oz.		10	25	17	0
19. Black Arrow dust	2.0 oz.		1	0	2	0
20. Black Arrow dust	4.0 oz.		1	0	1	0
21. Nicofume	1–100	1 hr.	0	39	2	0
22. Nicofume	1–200	1 hr.	38	105	15	23
23. Nicofume	1–400	1 hr.	37	137	0	49
24. Nicofume	1–100 & soap	1 hr.	1	2	1	0
25. Nicofume	1–200 & soap	1 hr.	0	13	8	22
26. Nicofume	1–400 & soap	1 hr.	7	57	1	43
27. Red Arrow	1–100	1 hr.	0	0	3	0
28. Red Arrow	1–200	1 hr.	2	17	13	1
29. Red Arrow	1–400	1 hr.	2	25	0	6
30. Hot water 110–111.5°F.		15 min.	1	127	2	162
31. Hot water 110–111.5°F.		30 min.	0	120	1	133
32. Hot water 110–111.5°F.		60 min.	0	47	1	0
34. Bichloride of mercury	1–500	1 hr.	2	1	0	0
35. Bichloride of mercury	1–1000	1 hr.	0	0	0	0
36–37–38 Check			76	88	187	8

The data show that the fumigation with calcyanide was effective in killing the adults and young thrips but not the eggs. Some control of the egg stage was apparently obtained when 1.5 grams (equals 1.3 pounds per 100 cubic feet) were used. There was considerable loss of gas through the walls of the paper bags as a distinct cyanide odor was noticeable very soon after closing the bags. Very little odor was noticeable when the bags were opened for ventilation after the fumigation periods of 5 hours or 10 hours. There was no injury apparent to the corms. It is realized that the dose used was too large for fumigating large storage chambers where the loss would be much less. If a second treatment had been made after the eggs hatched and before the young had developed to adults, complete control probably would have been obtained.

The carbon bisulphide did not kill either the adults or the young at the dosages used (equals approximately 1 pound and 2 pounds to 100 cubic feet). There was considerable leaking of the gas through the paper bags and very little odor was noticeable when the bags were opened for ventilation after the 5 and 10 hour periods. Carbon bisulphide has been used successfully in fumigating gladiolus corms as well as other corms and bulbs, and successful results would probably have been obtained in this test if a loss of the gas had not occurred through the paper bags. The fumes of carbon bisulphide are explosive and care must be taken in handling the material to see that fire is kept away during the fumigation period.

The paradichlorobenzene used at a rate equivalent to approximately ½, 1 and 2 pounds per 100 cubic feet, was not satisfactory. There was some reduction of thrips at the first examination but apparently no kill of the eggs, as indicated when an examination was made 4 weeks later. Fumes of the paradichlorobenzene were distinct at the first examination but no odor at the second examination. Loss through the paper bags failed to keep a lethal concentration of the gas until the eggs had hatched.

Naphthalene used at the same amount as the paradichlorobenzene was not effective except where the equivalent of 2 pounds to 100 cubic feet of space was used. No naphthalene odor was noticed at the time of the second examination in the bag containing the smaller amount and only a slight odor in the bag containing one gram. A strong odor was present in the bag containing two grams.

The 2% free nicotine dust was effective in all concentrations used. Almost all the thrips were killed at the time of the first examination and no live thrips were found when they were examined 4 weeks later.

Considerable dust was found under shucks surrounding the corms and there was a distinct nicotine odor in the closed bags.

The "Black Arrow" dust (a pyrethrum dusting powder) was effective where the 2 and 4 ounce doses were used, although apparently not as efficient as the nicotine dust. When the nicotine dust and the "Black Arrow" dust was applied to the corms in the bags, they were shaken thoroughly to distribute the dust evenly over the surface of the corms.

"Nicofume" (40% free nicotine) was effective only at a concentration of 1 part to 100 parts of water. The addition of ½ of 1% actual soap to the dilution, increased the wetting of the corms and the efficiency of the nicotine, but still left it less desirable than other materials. "Red Arrow" (a pyrethrum soap spray insecticide) was effective at a dilution of 1–100, and fairly effective at concentrations of 1–200 and 1–400.

Hot water, at a temperature of 110° to 111½° F., was effective in killing the adults and nymphs even when used for 15 minutes. It was only partially effective in killing the eggs when the corms were treated for 1 hour.

Bichloride of mercury used at a dilution of one ounce to 4 gallons (1–500) and 1 ounce to 8 gallons (1–1000) of water was quite effective in killing the adults and nymphs and in preventing reinfestation. This material probably acts as a stomach poison, remaining upon the corms and killing the young thrips after they hatch from the eggs.

The data from the tests indicate and is verified by experience with growers, that several materials or methods might be used successfully. Where one has only a few corms or a large number of varieties in small lots, treatment with naphthalene, paradichlorobenzene, nicotine dust or pyrethrum dust and storing the corms in paper bags or other closed containers should prove very satisfactory. Dipping the corms in bichloride of mercury for 1 hour or as much longer as is necessary to thoroughly wet under the husks is satisfactory. Other mercury compounds have been stated by growers to give good results in thrips control. Fumigation with cyanide or other fumigating material is easy, cheap and effective for larger quantities of bulbs and will give good protection if properly done. It may be necessary to repeat the fumigation in 2 to 3 weeks, depending upon the temperature, to kill the young thrips hatching from the eggs.

CONTROL OF THE THRIPS ON THE FOLIAGE AND BLOOM.—The control of the thrips on the foliage and bloom of growing plants is not as easily accomplished as control on the corms. Early egg laying and development of the young occur principally in the sheaths surrounding the stem or in the bloom where they cannot be easily reached with spray materials.

The greenhouse tests were conducted on gladiolus plants growing in 8″ lily pots, 6 plants to a pot. The plants were rather heavily infested at the time the tests were conducted. Both treated and untreated plants were kept together on the same bench in the greenhouse. Thus there was opportunity for migration of the adult thrips by flight or by the nymphs crawling from plant to plant.

All treatments were made at approximately weekly intervals. Counts were made of the total number of adult thrips and of nymphs exposed upon the foliage. These counts varied from one to three day intervals. The number of thrips found upon the plants varied considerably, depending upon the particular stage in their life history.

Since the same number of pots were not always used in the different experiments and since some experiments had a number of observations for determining the number of thrips, while other treatments had few observations, the final results have been based upon the average number of thrips found per pot per examination.

The spray tests were done at different times during February and March. For the sake of convenience all tests have been included in one table summarizing the results. Only those tests which seemed to show significant results have been given.

TABLE 2. SPRAY TESTS IN CONTROLLING THE GLADIOLUS THRIPS ON THE FOLIAGE OF PLANTS GROWN IN THE GREENHOUSE

Lot No. and composition of the spray material	Dilution	No. of pots sprayed	No. of times sprayed	No. of times counted	Total No. of thrips counted	Average No. of thrips per pot percount
16. Black Arrow Insect Dust 40 gms. Water 1000 cc		2	3	7	123	10.2
17. Awinc	1–100	2	3	7	577	48.0
18. Awinc+2% wheat flour	1–100	2	3	7	516	43.0
19. Derrisol	1–400	2	3	7	119	9.9
20. Derrisol+2% wheat flour	1–400	2	3	7	93	7.7
Check				1	175	175
21. Tensol 10 cc	0.5%	4	3	9	335	9.3
B.L. 50 2 cc	1–500					
Liquid lime sulfur 20 cc	1–50					
Water 970 cc						
22. Tensol (50%) 10 cc	½%	4	3	9	278	7.7
B.L. 50 2 cc	1–500					
Liquid L. S. 20 cc	1–50					
Lead Arsenate 4 gms	1⅜–50					
Water 978 cc						
23. Derrisol 2½ cc	1–400	4	3	9	727	20.2
Flour 20 gms	1–50					
Lead Arsenate 4 gms	1⅜–50					
24. Derrisol 10 cc	1–400	4	3	9	400	11.1
Dry Bordeaux 20 gms	8–8–50					
Lead Arsenate 4 gms	1⅜–50					
Water 980 cc						

TABLE 2. *Concluded*

Lot No. and composition of the spray material	Dilution	No. of pots sprayed	No. of times sprayed	No. of times counted	Total No. of thrips counted	Average No. of thrips per pot per count
25. Tensol 10 cc.	0.5%	4	3	9	1,044	29.0
Dry Bordeaux 20 gms. . . .	8–8–50					
Lead Arsenate 4 gms.	1¾–50					
Water 990 cc						
26. Black Arrow No. 5000 Insect Dust 40 gms.	1–25	4	3	9	479	13.3
Water 1000 cc						
27. Igepon A. P. 5 gms.	0.5%	4	3	9	1,167	32.4
B. L. 40 2 cc.	1–500					
Water 998 cc						
28. Igepon No. 27 5 gms.	0.5%	4	3	9	1,252	34.8
B.L. 40 2 cc.	1–500					
Flour 10 gms.						
Water 998 cc						
29. Penetrol 5 cc.	0.5%	4	3	9	865	24.0
B.L. 40 2 cc.	1–500					
Water 993 cc						
30. Nursery Volck 20 cc.	1–50	4	3	9	698	19.4
B. L. 40 2 cc						
Water 978 cc						
31. Wilsonite Dust 40 gms. . .	1–25	4	2	8	482	15.0
Water 1000 cc						
32. Wilsonite Dust as dust. . .		4	2	8	135	4.2
33. Black Arrow Insect Dust No. 2700 40 gms.	1–25	4	2	8	1,277	39.9
Water 1000 cc						
34. Black Arrow Dust No. 2700.		4	2	8	220	6.9
35. Lemon Oil Insecticide. . .	1–16	4	2	8	2,358	117.8
36. NOC (1½% rotenone dust) 40 gms.	1–25	2	1	8	44	2.7
Water 1000 cc						
37. NOC (1½% rotenone) as dust.		4	2	8	28	.87
38. Black Arrow Dust No. 5000 as dust.		4	2	7	263	9.4
44. NOC Special rotenone dust (1½% rotenone)		4	2	7	30	1.0
45. Hellebore 40 gms.	1–25	4	2	5	48	2.4
Water 1000 cc						
46. Hellebore as dust.		4	2	5	89	4.4
47. NOC special rotenone dust 40 gms.	1–25	1	2	5	9	1.8
Water 1000 cc						
48. Talc as dust.		4	1	3	123	10.2
49. Rotenone powder 70–72% rotenone 1½ gms.	1.5%	4	1	3	212	17.7
Talc 70 gms.	rotenone					
50. Rotenone powder 70–72% rotenone 1½ gms. . .	1.5%	4	1	3	50	4.2
Talc 35 gms.	rotenone					
Sulfur 35 gms.						
51. 5% rotenone in acetone 10 cc.	1.5%	4	1	3	6	0.5
Talc 90 gms.	rotenone					

Table 2 gives the results of the greenhouse tests in controlling the gladiolus thrips on the foliage.

The average number of thrips per pot per count varied considerably. Most of the liquid sprays containing nicotine, pyrethrum, or rotenone were not very effective in reducing the thrips population. The use of arsenate of lead, or of Bordeaux, or of liquid lime sulfur solution did not increase the efficiency of the sprays. The best results were obtained with dust insecticides applied as dusts or as thin washes of the dust. Wilsonite which contained nicotine, Bordeaux, calcium arsenate and an inert carrier had excellent physical properties. It was observed that fine dust materials acted mechanically in keeping the plants free from thrips as the dust collected on the tarsi of the thrips and they could not keep a foothold.

The dusts containing rotenone were somewhat more effective than the pyrethrum dusts. This may have been partly due to their better physical properties and high rotenone content. Hellebore was very good, especially considering its price as compared with the price of the other dusts. The addition of sulfur to the one rotenone dust apparently increased its efficiency. Field observations have also indicated that sulfur has considerable beneficial results.

In general, the dust materials applied as dusts or as thin washes were more efficient than the usual liquid contact or stomach sprays. This increased efficiency may possibly be partly due to the higher per cent of active principle (such as rotenone, pyrethrins, nicotine, etc.) in the dusts and a greater amount of the insecticide remaining upon the foliage in the dust applications. The amount of active or toxic agents in the dusts varied from one to several hundred times as much as was used in the diluted liquid sprays.

Field Tests in Controlling the Thrips.—The field tests on the gladiolus thrips were directed towards several different things as follows; (1) the development of a dust material which had the best physical properties for use on the gladiolus plants, (2) the development of a dust material which could be applied as a thin wash and which would give good wetting and coverage, (3) the comparison of several different contact sprays.

A number of different kinds of inert dusts were tested as carriers of extracts of rotenone or pyrethrins or used for diluting ground cube root, derris root or pyrethrum flowers. Several samples of a diatomaceous earth were obtained from the Johns Manville Company's plant at Manville. Most of these dusts were very light and fluffy and when mixed with extracts of rotenone or pyrethrins or when diluted with ground

cube or derris roots they gave very light fluffy dusts which dusted beautifully. Unfortunately the dusts would not adhere to gladiolus foliage or in fact to other foliage. The dust particles were so light that they were not deposited on the foliage or were blown off by the force of the dusting in attempting to apply additional dust.

Talc when impregnated with extracts of rotenone or pyrethrins or when mixed with the ground roots was rather heavy for application with hand dusters. It was difficult to obtain an even distribution because of the dust packing and not coming out of the duster evenly. Talc did not adhere well to the foliage after rains.

A dusting clay manufactured by Hammill and Gillespie of New York City had the best properties for dusting and adhering to the foliage. The clay was heavy enough to be applied satisfactorily but did not pack similar to the talc. The clay also wet fairly well with water and proved the most satisfactory inert carrier for use in making materials to be applied as thin washes.

Three of the most satisfactory dust materials were made up as follows:

No. 1. "Inert C" dust	50%
Powdered air floated derris root containing 4% rotenone	25%
Dusting sulfur	25%
No. 2. "Inert C" dust	82½%
Alcoholic extract of pyrethrum flower containing 2.2% pyrethrins	5%
Powdered air floated derris root containing 4% rotenone	12½%
No. 3. "Inert C" dust	67.8%
Powdered air floated derris root containing 4% rotenone	25%
Powdered soap	7.2%

The number 1 dust containing sulfur dusted well and adhered to the foliage reasonably well. The number 2 dust did not dust quite as good as the number 1 dust but would wet with water and wet gladiolus foliage reasonably well. It was used at the rate of 1 pound to 3 gallons of water for a spray. The number 3 dust was applied only as a spray diluted 1 pound to 3 gallons of water. It wet gladiolus foliage well and gave a uniform coating upon drying. Only sufficient soap was added to the dust to produce wetting when used at dilutions of 1 pound to 3 gallons of water. Additional soap caused excessive run off of the spray with a smaller amount of dust on the foliage upon drying.

One pound of dust used as a wet spray covered from 3 to 5 times more gladiolus foliage with better results than did the same amount of dusts.

Several commercial brands of pyrethrum or pyrethrum and rotenone sprays were tested on gladiolus foliage. It was necessary to use most of

these considerably more concentrated than recommended to obtain satisfactory wetting of gladiolus foliage.

The dust materials applied as dusts or as thin washes diluted one pound to 3 gallons of water gave better control of the gladiolus thrips than the liquid contact sprays. The per cent of rotenone or of pyrethrins in the dust materials was considerably greater (from 50 to 100 times) than in the diluted contact sprays. This undoubtedly had considerable to do with the better results.

It was observed that field spraying should be started early on young plants and before an infestation was built up if control was to be obtained. Applications should be made at approximately weekly intervals. Materials which gave satisfactory control of the thrips when applied early and regularly, failed to give control when used on infestations where the thrips were abundant and severe injury was beginning.

MR. FRIEND: I should like to ask how much Paris green and brown sugar is used?

MR. H. H. RICHARDSON: The formula is Paris green one ounce, brown sugar two pounds, and water to make three gallons.

MR. J. A. MANTER: I should like to ask about how much naphthalene flakes should be used in a five-pound bag, nearly full of corms.

MR. HAMILTON: We have been recommending around an ounce to 150 corms.

MR. WEIGEL: In the paper, I gave results. A check-up we made among growers in quite widely separated areas in New York State, and also around Washington, proved naphthalene, one ounce to one hundred, the best. Scatter it among the corms after they are sufficiently cured, not earlier than a month after they are brought in from the field and preferably by midwinter. Cyanide fumigation also was successful, but if the interval was not definitely observed, they would not get complete control

As Mr. Smith pointed out, with the carbon tetrachloride, that also has the advantage of killing all stages at one treatment. However, the growers are rather lax in observing the necessary precautions in over dosage and also over exposure.

MR. CUTRIGHT: In reference to the use of naphthalene in corms stored in fruit cellars, in Ohio it is customary for a number of people to store corms with the various other lots they may have, fruit, and so on. We all know that apples will take on a decided flavor which renders

them very unpalatable if placed close to naphthalene. That must be taken into account.

MR. SMITH: A precaution should be mentioned, because naphthalene will injure the growing rootlets or sprouts So the treatment should be applied before growth has broken the dormant period. Also, if at the time of planting any flakes are left among corms, these should be shaken out.

MR. HUTSON: I should like to ask Mr. Smith in regard to his one treatment with semesan. There is semesan this and semesan that. Was there any qualification of that semesan?

MR. SMITH: This material contained 30 per cent of the active ingredient.

MR. HAMILTON: Mr. White, in the experiment station in New Jersey, has done considerable work with other mercury compounds from the standpoint of control of disease, and his general observations have been that a number of those are also effective in controlling thrips. It was not done as experimental work from that standpoint, but he believes they are just as good possibly as mercury and semesan and some of them, he says, may be better for fungus growths.

We tested out two others, calomel and semesan. These are recommended, we are told, by the Bureau of Plant Industry as dips for five to ten minutes; used at these exposures, they were not effective against thrips. With longer exposures there was satisfactory control.

MR. HUTSON: I have some data, similar to that Mr. Hamilton gave, using it for disease control on gladioli corms, and getting rid of the thrips. The work was not done in an experimental way, but it would seem to indicate the material might be used.

Friday Evening, December 30, 1932

COMPATIBILITY OF OIL EMULSION-CRESYLIC ACID SPRAYS WITH FUNGICIDES[1]

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ABSTRACT

Laboratory tests have shown that stable spray mixtures can be prepared from oil emulsions containing cresylic acid with either freshly prepared Bordeaux or lime sulfur containing organic colloids. Orchard experiments on five blocks of apple trees have shown that the addition of fungicides do not in any way interfere with the toxicity of either oil emulsion to red mite eggs or of cresylic acid to aphis eggs.

The purpose of the experiments presented in this paper was two fold: First, to adjust the oil emulsion-cresylic acid spray so as to make it compatible with either Bordeaux or lime sulfur; Second, to determine whether the admixture of the above fungicide will in any way affect the toxicity of either the oil to red mite eggs or the cresylic acid to aphis eggs.

REVIEW.—During the last three years the combination of oil emulsions with cresylic acid has been extensively applied by orchardists in New Jersey as a delayed dormant spray to control scale, red mite, and aphis on apple trees. It has been shown that (1) the cresylic acid in this mixture compares well with nicotine in its efficiency to control aphis and does not in any way interfere with the toxicity of the oil to scale and red mite eggs. This spray was first recommended by Dr. Headlee as a result of laboratory and orchard experiments conducted (1, 2) in 1927 and 1928, on apple trees. The practical advantage to the farmer in using this spray mixture in preference to nicotine is an actual saving of money.

It should be noted here that, cresylic acid is merely a trade name to designate a mixture of certain acidic coal tar distillates which usually contain phenol, cresols, xylenols, and other acidic groups of still higher boiling points. There are several commercial grades of cresylic acid on the market in which the proportions of the above constituents vary considerably. In our experiments we found that 0.5% cresylic acid of the following specifications was efficient in killing aphis eggs when combined with oil emulsion containing 3% actual oil and caused no appreciable injury to peach and apple buds in the delayed dormant stage:

Boiling range	205 – 240°C.
Xylenols	60 – 70%

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

Cresols	15 – 25%
Acids of higher boiling points	5 – 25%
Phenol	none or a trace

Ever since the cresylic acid-oil spray assumed commercial importance, the problem of incorporating a suitable fungicide confronted us. Such a combination would give protection from scale, aphis, red mite, and scab in one application, thus still further reducing the spray cost. While miscible with oil in all proportions, cresylic acid does not mix readily with either lime sulfur or with commercial Bordeaux, unless coated with protective colloids.

During the early spring of 1930 experiments were carried out in a commercial orchard (3) with oil soluble copper oleate as a possible fungicide. The compound was dissolved in the oil and then emulsified with soap. The resultant emulsion mixed readily with cresylic acid, but the fungicidal value of copper oleate proved inferior to either lime sulfur or Bordeaux. The tests with the above fungicide against apple scab were carried out by Dr. W. Martin, Plant Pathologist and Dr. A. C. Sessions.

Laboratory and field experiments conducted in a preliminary way during 1931 (4) have shown that:

1. Either copper ammonium silicate (prepared by Dr. Sessions) or commercial Bordeaux containing 10% bone-glue mixes readily with cresylic acid.

2. Colloidal cresylic acid (prepared by incorporating 10 to 20% soap) produces a more stable mixture with either the oil emulsion alone or with the oil emulsion containing the copper fungicide.

3. The above combinations did not reduce the toxicity of the oil to red mite eggs, nor the toxicity of cresylic to aphis eggs.

EXPERIMENTAL.—During the spring of 1932 experiments were conducted in the college apple orchard with cresylic-acid-oil-emulsion sprays to which either lime-sulfur or home-made Bordeaux was added. Previous to the field experiments, various mixtures of oil, cresylic, Bordeaux, and lime sulfur were tested in the laboratory. The results presented in Table 1, show that freshly prepared Bordeaux of 4–6–50 formula, unlike the commercial powdered Bordeaux, mixes without any difficulty with oil emulsions containing cresylic acid and leaves no objectionable residue in the spray tank. On the other hand, lime sulfur forms flocculent precipitates with cresylic or with oil emulsions containing soap emulsifiers, when used either separate or combined, due to the formation of insoluble calcium salts. The flocculation was eliminated when the lime sulfur was mixed with powdered skim milk, 3 pounds to

100 gallons, and colloidal cresylic acid instead of the ordinary 95% cresylic was used.

FIELD EXPERIMENTS.—In order to study the effect of either lime sulfur or Bordeaux on the toxicity of the oil-cresylic acid mixture in the field, 5 blocks of apple trees in the college farm, heavily infested with overwintered eggs of aphis and red mite were sprayed as enumerated in Table 2. Each block contained six trees including the following varieties: Grimes, Stayman, Wealthy, and Paragon.

The following procedure was used in preparing the sprays in 100 gallon tank capacity.

TABLE 1. LABORATORY TESTS WITH OIL EMULSIONS, CRESYLIC ACID AND EITHER LIME SULFUR OR HOME-MADE BORDEAUX

Test No.	Composition of Spray Mixture	Stability of mixture
1.	Bordeaux 4–6–50 Cresylic 0.5% Oil 3.0% (soap emulsifier)	Good
2.	Bordeaux 4–6–50 Cresylic 0.5% Oil 3.0% (ammonium caseinate emulsifier)	Good
3.	Lime sulfur 1:9 Cresylic 0.5% Oil 3.0%	Breaks up
4.	Lime sulfur 1:9 Cresylic 0.5% Oil 3.0% Skim milk 3 lbs. to 100 gallons	Breaks up
5.	Lime sulfur 1:9 Colloidal cresylic 0.5% Oil 3.0%	Breaks up
6.	Lime sulfur 1:9 Colloidal cresylic 0.5% Oil 3.0% Skim milk 3 lbs. to 100 gallons	Good
7.	Lime sulfur 1:40 Cresylic 0.5% Oil 3.0%	Breaks up
8.	Lime sulfur 1:40 Cresylic 0.5% Oil 3.0% Skim milk 3 lbs. to 100 gallons	Breaks up
9.	Lime sulfur 1:40 Colloidal cresylic 0.5% Oil 3.0%	Breaks up
10.	Lime sulfur 1:40 Colloidal cresylic 0.5% Oil 3.0% Skim milk 3 lbs. to 100 gallons	Good

1. *Bordeaux Spray.* As soon as the water and agitator were started in the tank, about 8 pounds of copper sulfate (Snow) were added. When the tank was about 2/3 full and most of the copper sulfate dissolved, 12 pounds of hydrated lime were sifted in. While the agitator continued to run, oil emulsion, enough to make up 3% actual oil, was mixed in. The cresylic acid was added last. The rest of the water to make up 100 gallons was then run in.

2. *Lime Sulfur Spray.* When the tank was about half full with water the agitator was started. About three pounds of powdered skim milk (first made into a thin paste with a small amount of water in a separate container) were added. The concentrated lime sulfur was then added. When the mixture of skim milk and lime sulfur became uniform the oil emulsion and finally the colloidal cresylic acid were mixed in. The water was then allowed to fill up the tank to 100 gallons. Two strengths (1:9 and 1:40) of lime sulfur were used. While the lower concentration is sufficiently strong as a fungicide and is usually recommended for special scab spray, it was considered advisable also to test the winter concentration of lime sulfur, the highest strength the apple trees can stand without severe injury in the delayed dormant stage.

Two types of commercial oil emulsions were used with the Bordeaux spray. One contained soap emulsifier, obtained from Mechling Bros. Chemical Company, Camden, N. J., while the second, contained ammonium caseinate emulsifier obtained from Sherwin-Williams, Bound Brook, N. J. The colloidal cresylic acid was prepared by incorporating about 20% soap in the ordinary 95% cresylic acid. The skim milk was produced by the "Spray" process and readily dissolved in cold water.

Several days before the sprays were applied, a total of 560 twigs, collected from every tree in the blocks were examined for red mite and aphis eggs. About 504 twigs had red mite eggs ranging from a few to too numerous to count, while 254 twigs had aphis eggs ranging from 1 to 4 per twig. These observations indicate that out of every 100 twigs 90 contained red mite eggs and 45 contained aphis eggs suggesting approximate infestation of 90% and 45% for the two insects respectively. The sprays on the five blocks were applied on April 16 and counts of hatched aphis and red mite were made by Mr. C. Ilg (laboratory Assistant) on May 9 and May 16 when the leaves were from ½ to 1 inch out. A total of 100 fruit spurs per block, collected at random, from every tree were examined each time. Since it was not practical to leave a block of trees entirely unsprayed to serve as checks, about 200 twigs containing both, red mite and aphis eggs were placed in jars of water and kept in the

greenhouse until the leaves were about half an inch out. Counts of live aphis and red mite were then made on 100 fruit spurs.

The results tabulated in Table 2, show that the highest number of live aphis in any one of the blocks was five, while the highest number of live red mites was only 3 per 100 fruit spurs. Keeping in mind the large abundance of both aphis and mite eggs present on the twigs, the writer considers this as very good control No appreciable differences in control are observed between the five different spray combinations tested. When compared with block 5 where no fungicide was used, it becomes evident that neither the home-made Bordeaux nor the lime sulfur has in any way reduced the toxicity of either cresylic acid to aphis eggs or the oil to red mite eggs.

TABLE 2. FIELD TESTS WITH OIL-CRESYLIC SPRAYS CONTAINING EITHER HOME-MADE BORDEAUX OR LIME SULFUR

Block No.	Composition of spray	Date sprayed	Examined 5/9 No. of live Aphis per 100 spurs	Examined 5/9 No. of live Red Mite per 100 spurs	Examined 5/16 No. of live Aphis per 100 spurs	Examined 5/16 No. of live Red Mite per 100 spurs
1	Bordeaux 4–6–50 Cresylic 0.5% Oil 3.0% (Soap Emulsifier)	4/16	3	0	5	1
2	Bordeaux 4–6–50 Cresylic 0.5% Oil 3.0% (Ammonium caseinate emulsifier)	4/16	2	1	3	0
3	Lime sulfur 1:40 Colloidal cresylic 0.5% Oil 3.0% Skim milk in 100 gals. 3 lbs.	4/16	3	1	5	3
4	Lime sulfur 1:9 Colloidal cresylic 0.5% Oil 3.0% Skim milk in 100 gallons. 3 lbs.	4/16	4	0	2	1
5	Cresylic 0.5% Oil 3.0% (Soap emulsifier)	4/16	3	1	4	3
Check	Untreated apple twigs kept in the greenhouse		62	281	–	–

SUMMARY AND CONCLUSIONS.—Laboratory tests with oil-emulsion-cresylic-acid spray mixtures were carried out with the purpose of improving their stability with fungicides such as Bordeaux and lime sulfur. Following the laboratory tests, field experiments were conducted on

five blocks of apple trees with as many selected spray mixtures in order to determine whether the addition of fungicides to an oil cresylic spray will in any way affect its toxicity to the eggs of either aphis or red mite.

The laboratory results have shown that:

1. Freshly prepared Bordeaux of 4–6–50 formula produces a stable mixture with oil emulsions containing 0.5% cresylic acid.

2. Lime sulfur is not compatible with oil emulsions containing cresylic acid.

3. When treated with powdered skim milk or similar colloids, lime sulfur forms stable spray mixtures with 0.5% colloidal cresylic acid.

The field experiments have shown that:

1. Incorporating either Bordeaux or lime sulfur in oil-cresylic sprays did not decrease their toxicity to eggs of aphis and red mite.

2. Combining oil-cresylic sprays with either "home-made" Bordeaux or lime sulfur in order to control scale, aphis, red mite and fungous diseases is practical and economical.

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Mr. C. H. Richardson: I should like to ask whether this can be used in mid-summer on trees and foliage?

Mr. Ginsburg: I should say it cannot be used because we have two per cent oil. The oil by itself will cause injury. Half of one per cent cresylic acid, and the combination of the two will cause injury. It is used primarily as a delayed dormant spray applied when the leaves are just coming out, the size of squirrel ears.

President Flint: I should like to ask Mr. Ginsburg if he ever used this combination on peach. We have many orchards planted with peach and apple.

MR. GINSBURG: I have used a combination of oil emulsion and cresylic acid on peach, even at the high concentration indicated in this paper, namely, one per cent cresylic acid, with no injury, at the same time of the year. I concluded that the peach tree in the dormant stage can stand oil and cresylic acid better than the apple. I have not used it on the peach, but I think there would not be injury from the addition of lime sulfur.

PRESIDENT FLINT: At the time you would be using that for aphis on the apple, the peach trees would be further advanced, very likely in bloom. Do you think it would be injurious at that time?

MR. GINSBURG: I have used it at the stage when the peach bud is turning red. I killed red mite on peaches with this spray, without any injury, whatsoever.

MR. HEADLEE: I think it is essential, in speaking of the delayed dormant spray, to point out that this delayed dormant spray period is not the same as the delayed dormant spray period in New York State.

This period begins when the bud scales of the fruit buds begin to separate and show the silvery lines on the buds and closes before the little leaves stick up.

ARSENICAL RESIDUES FOUND ON APPLES IN THE PACIFIC NORTHWEST THROUGHOUT A SEASON OF TYPICAL SPRAYING WITH LEAD ARSENATE[1]

By R. H. CARTER, *Bureau of Chemistry and Soils* and E. J. NEWCOMER, *Bureau of Entomology*

ABSTRACT

Samples of apples from trees which had been sprayed throughout the season with lead arsenate were selected before and after each spray and at harvest time and analyzed for arsenical residue. A fairly uniform minimum coating of about .006 mg./sq. cm. was found to have been maintained during the season by spraying about every ten days when growth was rapid, and every two or three weeks later on. This coating was increased to about .012 mg./sq. cm. by each of the various applications, resulting in an average coating of about 0.10 mg./sq. cm. The relationship between the residue results calculated as grains per pound and as milligrams per square centimeter is discussed. The percentages of the total accumulated residue at harvest time put on by each spray is indicated.

Pure food regulations place a maximum limit on the quantity of arsenic allowed on apples when they are marketed, while effective con-

[1]Presented at the Forty-Fifth Annual Meeting of the American Association of Economic Entomologists, Atlantic City, N. J., December 28 to 31, 1932.

trol of the codling moth sets a minimum limit on the deposit carried by the fruit during the growing season. Since the legal limit is stated in terms of weight of residue per pound, and control experiments can best be discussed in terms of weight per unit area of fruit, a study of arsenical residues on apples must include a consideration of the relation of deposit to both weight and surface area, and the constantly changing relationship of these two measures caused by the growth of the fruit.

The relation of weight of deposit to weight of apple is easily determined, but the relation to surface area is not so simple. The writers have examined several methods of determining the area of apples. Barnes (1) has described an apple as a cardioid and has given a formula for the calculation of the surface area on this basis. Magness et al. (2) have assumed an apple to be a sphere, and it may also be considered as an oblate spheroid. Markley and Sando (3) in determining the quantity of wax on apples, have used disks cut from the surface, and have given a formula for the determination of the area of the disks. The writers have calculated the surface area of apples from weight according to these three assumptions of shape, (with further plausible assumptions concerning eccentricity in the case of the spheroid) and have found the results to be within two or three per cent of each other. They have also found that the result for residue per unit of surface area is practically the same whether calculated on the basis of these assumptions or from the analysis of disks cut from the surface.

For the purposes of this investigation, therefore, the simplest method has been used, that of determining the residue on entire apples and of calculating surface area from weight by assuming that the apples are spheres and have uniform known density.

By submerging Winesap apples in water it was found that they displaced about 1.2 cc. per gram and that this relationship did not vary greatly during the season. The surface area (S.A.) was therefore obtained by using the formula $\text{S. A.} = 4.84 \left[\sqrt[3]{(\text{wt.} \times 1.2)}\right]^2$. A spray schedule was chosen for this investigation that is fairly typical of those used in the Pacific Northwest (Table 1). The first four cover sprays were applied during the occurrence of the first brood of the codling moth, and the fifth and sixth cover sprays during the second brood. Samples, each consisting of 10 to 50 apples, were obtained from the orchard before and after each cover spray, and at harvest time. The arsenical deposit was removed by the ordinary rapid solvent method, and arsenic determined by the Gutzeit method. The average weight of the apples in each sample was found and from it the area was calculated. The quantity of arsenic was calculated in terms of grains of As_2O_3 per pound of

fruit, milligrams per apple, and milligrams per square centimeter of surface. These data are given in Table 2. This has been repeated, at least for a portion of the season, for several years, but as the results are in

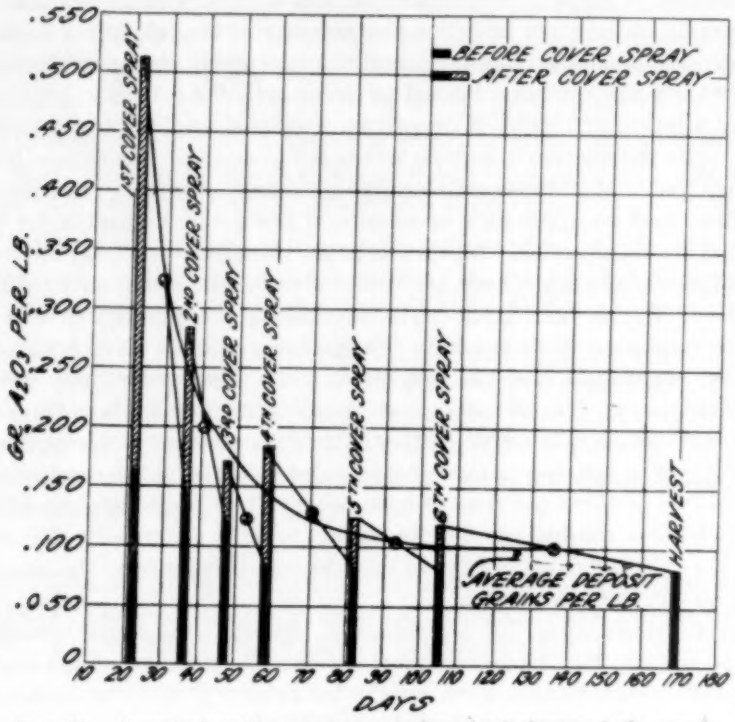

FIG. 42.—Arsenical residues per pound of apples before and after each cover spray and at harvest.

substantial agreement, only the figures for 1930 are given. The result obtained after the first cover spray is abnormally high, because the lead arsenate was used 50 per cent stronger than in the other applications. Normally, this deposit should have been about .333 grain per pound.

In spite of random sampling, there are some variations in the results, but the important relationships between deposit and growth of fruit are shown.

Considering first the deposit per pound of fruit, Figure 42 shows that this is high early in the season when the fruit is small and later on becomes less. On the other hand Figure 43 shows that the surface density of deposit fluctuates about a nearly constant figure. This difference is of course due largely to the fact that the weight and surface area

of a sphere do not increase proportionately, the weight increasing the more rapidly. In order to show this, the relationship of surface area to weight and growth curves based on each of these magnitudes are given

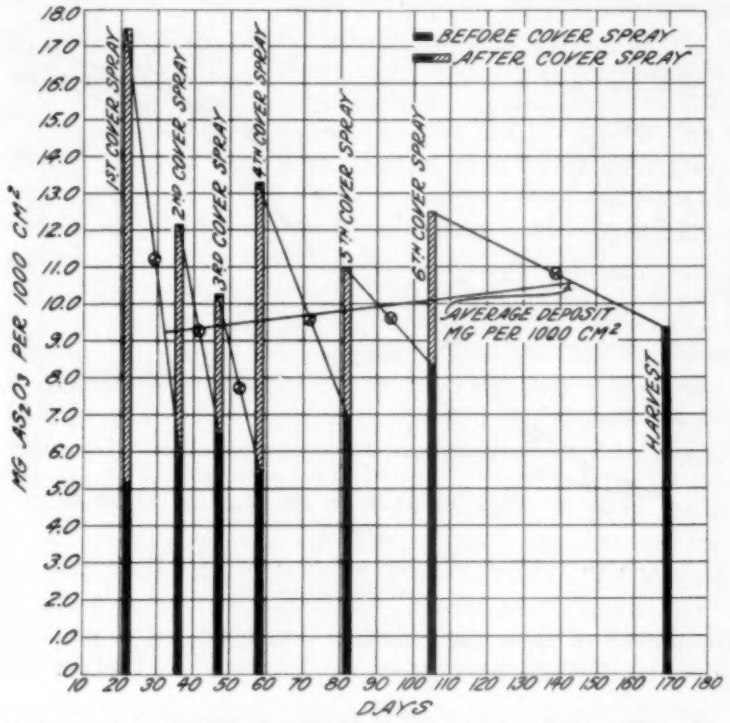

FIG. 43.—Arsenical residues per thousand square centimeters of apple surface before and after each cover spray and at harvest.

in Figure 44. At the time of the earlier sprays, the apples had a surface area, in square centimeters, many times their weight in pounds and this ratio continuously decreased throughout the season as is shown in Figure 44.

Since the apples have little area early in the season, the percentage of the final residue resulting from the earlier sprays is relatively small. This is shown in Table 3, the quantity of As_2O_3 placed on the fruit by each application, in terms of milligrams per apple, having been derived from the data in Table 2, and the grains per pound figured from this, using the average weight at the time of each application. The percentages of the final residue are figured in the same manner, using the average weight of .221 lbs. at harvest, and are shown graphically in

Figure 45. The first four cover applications, which are those made for the first brood of the codling moth, put on only about 40 per cent of the total residue, and the first three cover applications did not put on more than 20 per cent of the total.

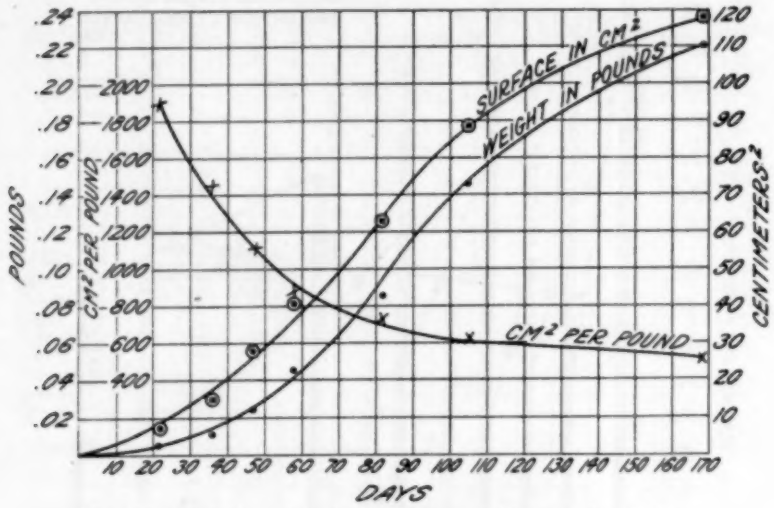

FIG. 44.—Relation of surface area to weight of apples during growing season.

The control of the codling moth is dependent not so much on the total deposit of lead arsenate as on the distribution of that deposit over

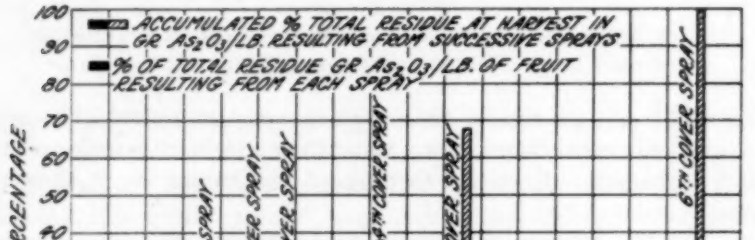
ACCUMULATED % TOTAL RESIDUE AT HARVEST IN GR As2O3/LB. RESULTING FROM SUCCESSIVE SPRAYS
% OF TOTAL RESIDUE GR As2O3/LB. OF FRUIT RESULTING FROM EACH SPRAY
PERCENTAGE
CALYX
1ST COVER SPRAY
2ND COVER SPRAY
3RD COVER SPRAY
4TH COVER SPRAY
5TH COVER SPRAY
6TH COVER SPRAY
DAYS

FIG. 45.—Percentage of final spray residues resulting from each application of spray.

the period when the larvae are active. If possible, the applications should be timed with respect to weather conditions and the hatching of the eggs in such a manner as to have the heaviest deposit on the fruit when the largest number of larvae are hatching. In the schedule upon which these studies are based, for example, there was a relatively long interval between the first and second cover sprays because the weather was cold and there were few eggs hatching at that time. The interval between fourth and fifth sprays was long as it came between the first and second broods, and few eggs were hatching. During the time the second brood was active (July 15 to September) the fruit was growing more slowly, and there was little loss of deposit by weathering, hence it was unnecessary to spray as often as during May and June. It should be understood that the results obtained from these studies are dependent on the climatological and horticultural conditions surrounding the experiments. Therefore, it cannot be assumed that the same results would be obtained in other seasons or in other localities, but they are at least indicative of what to expect. The distribution may be judged by means of the deposit per square centimeter of surface at various times during the season, as shown in Figure 43. The spray schedule used in these experiments maintained a minimum coating of about .006 mg. / sq. cm., and this coating was increased to about .012 mg. / sq. cm. by each of the various applications, resulting in an average coating of about .010 mg. /sq. cm. It is obviously impossible to maintain a uniform coating at all times. The very rapid growth early in the season, as shown in Figure 44, results in a rapid thinning of the deposit, and it is necessary, in heavily infested orchards, to spray about every ten days during the activity of the first brood, as was done in this case; and very often it is also necessary to add oil emulsion to the spray or to use more lead arsenate.

The schedule used controlled the worms quite well but resulted in a rather high residue at picking time. This deposit compares favorably with that found in other sprayed orchards as Spuler and Dean (4) have stated that, in orchards in the Wenatchee District receiving six cover sprays, a deposit of 75 micrograms per square inch of surface was found ten days after the last spray. This is equivalent to slightly less than 0.012 mg. /sq. cm., which is about what was left with our schedule ten days after the last application. It cannot be assumed that such a deposit will always control, as these authors have further stated that the type of deposit is also important. Figure 46 has been constructed for those who desire to focus their attention upon the surface density of

deposit, rather than upon the customary value of grains As_2O_3 per pound. It gives the factor by which grains per pound should be multiplied to obtain milligrams per square centimeter. The factor is of course dependent upon the average weight of single apples and is based upon

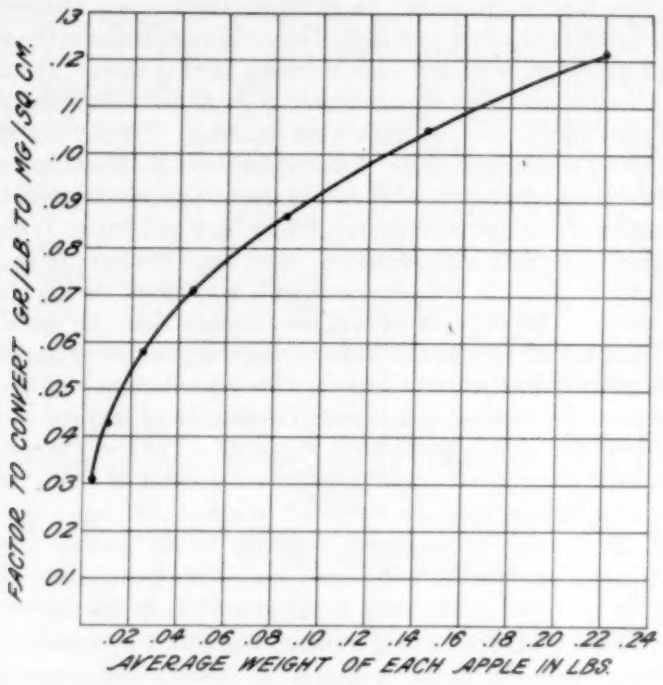

FIG. 46.—Factors for converting grains per pound into milligrams per square centimeter.

the assumptions previously made, that apples are spheres and have a density of 0.83 grams per cc.

CONCLUSIONS.—It is evident from these studies that the major part of the spray residues on harvested fruit is due to the late applications. This is important, as it indicates at once that substitutes for lead arsenate are of much greater value in the late sprays than in the early sprays. By using such substitutes in only the last two applications of the particular schedule under consideration 60 per cent of the final arsenical residue could be avoided, with a consequent simplification of residue removal.

These studies also show that under the conditions of the experiment spraying should be done about every ten days during May and June.

when the first brood of the codling moth is active, in order to maintain a fairly heavy coating, as there is a rapid loss on account of weathering and growth of the apples.

It is also evident that the figures representing grains of arsenical residue per pound tend to decrease throughout the season while the figures for mg. per sq. cm. of surface area tend to remain constant or to increase. This is due to the different rates of increase of weight and surface area.

TABLE 1. SPRAY SCHEDULE USED IN DETERMINING ARSENICAL RESIDUES

Application	Date	Treatment
Calyx	May 1	Lead arsenate, 3 lbs. to 100 gals.
First cover	May 22	Lead arsenate, 3 lbs. to 100 gals.
Second cover	June 4	Lead arsenate, 2 lbs. to 100 gals., and emulsified oil, ¾%
Third cover	June 15	Lead arsenate, 2 lbs. to 100 gals.
Fourth cover	June 26	Lead arsenate, 2 lbs. to 100 gals.
Fifth cover	July 20	Lead arsenate, 2 lbs. to 100 gals., and emulsified oil, ¾%
Sixth cover	Aug. 12	Lead arsenate, 2 lbs. to 100 gals.
Harvest	Oct. 15	

TABLE 2. DEPOSIT OF ARSENICAL RESIDUE FOUND ON APPLES BEFORE AND AFTER EACH COVER SPRAY AND AT HARVEST

Time of sampling in relation to cover sprays	No. apples	Av. wt. lbs.	Av. wt. grams	Av. area sq. cm.	Deposit of As_2O_3 grains/lb.	mg./apple	mg./sq. cm.
Before 1st	50	.003	1.4	6.1	.160	.032	.0052
After 1st	50	.005	2.2	9.2	.509	.160	.0174
Before 2nd	50	.011	5.0	15.9	.134	.094	.0059
After 2nd	50	.010	4.5	14.9	.280	.180	.0120
Before 3rd	50	.023	10.6	26.4	.115	.174	.0065
After 3rd	50	.027	12.4	29.3	.169	.300	.0102
Before 4th	50	.042	18.8	38.8	.078	.210	.0054
After 4th	25	.050	22.4	43.4	.181	.580	.0133
Before 5th	20	.081	36.5	60.1	.081	.425	.0071
After 5th	20	.092	41.5	65.5	.123	.725	.0110
Before 6th	20	.148	67.0	90.2	.078	.750	.0083
After 6th	10	.142	64.5	87.9	.119	1.100	.0125
Harvest	18	.221	100.0	117.8	.0775	1.112	.0094

TABLE 3

	Gain in gr./lb. harvested weight	Amount put on Amount found
From calyx	.0022	2.8%
From 1st cover spray	.0046	6.1
From 2d cover spray	.0055	7.1
From 3rd cover spray	.0025	3.2
From 4th cover spray	.0150	19.3
From 5th cover spray	.0226	29.1
From 6th cover spray	.0251	32.4
Harvest	.0775	100.0%

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A METHOD OF RAPIDLY APPLYING LIQUID SOIL INSECTICIDES[1]

By J. M. MERRITT, C. B. DIBBLE, O. E. ROBEY, *East Lansing, Michigan*

ABSTRACT

Economical application of large quantities of dilute soil insecticides by means of a porous hose, the dilution of the active ingredient being effected by pumping into the water supply. Other applications for the method are suggested.

Control of a soil-inhabiting pest, undertaken during the past summer, necessitated treating a considerable area with carbon disulphide emulsion as recommended for the control of the Japanese beetle (1)[2]. Distribution of the material through an aspirator type of proportioning machine having a possible capacity of 250 square feet per hour actually resulted in the treatment of about 100 square feet per hour. The operation of the machine required one man, who directed the distribution of the emulsion through a single nozzle.

The situation required the even distribution of the emulsion over a larger area in order to increase the area treated per man hour. This was accomplished by pumping the miscible carbon disulphide solution at a definite rate into the water supply, thus obtaining the proper emulsion, which was subsequently distributed over several hundred square feet simultaneously through a porous hose, such as is used at this Station for irrigation purposes (2).

The water was supplied by a centrifugal pump through a two-inch pipe line, Venturi meter measurements showed that this pump was capable of delivering 120 gallons per minute with ten pounds pressure at the end of the pipe line. The injection of the solution into the pipe

[1]Work done by C. B. Dibble and J. M. Merritt, Section of Entomology, in collaboration with O. E. Robey, Section of Agricultural Engineering, Michigan State College.—Jour. Article No. 135 (n. s.) from Mich., the Mich. Agr. Expt. Sta.

[2]Reference is made by number to "Literature Cited."

line was accomplished by means of a small reciprocating force pump. The pump was made of bronze and fitted with two cylinders: bore ⅝ of an inch, stroke ½ inch. The pump, operated by a ¼ horse-power electric motor at 126 r.p.m., had a capacity of 500 cc. per minute. The flow of solution from the pump was governed by a pressure relief valve and a metering valve, protected against clogging by a 60-mesh screen. The resulting emulsion was distributed through unsized canvas hose made of 12-ounce duck, 2½ inches in diameter. When filled with water at ten pounds pressure, 12½ gallons seep uniformly through the pores of the fabric per 100 feet of hose per minute.

In testing this apparatus a single 200-foot length of porous hose was used, and the flow of water was regulated and maintained at 25 gallons per minute and ten pounds pressure, by using two gate valves, a meter, and a pressure gauge in the pipe line. In order to meet the requirements of the recommendations for the application at a soil temperature of 50–60 degrees F., 57 cc. of solution must be added to every ten gallons of water and applied at the rate of 2.5 gallons per square foot of soil treated. This was accomplished by injecting the solution into the pipe line at a pressure of seventeen pounds on the pump gauge, maintained by regulation of the relief valve. The flow was governed by a metering valve, previously calibrated by drawing the solution from a graduated container and timing with a stop watch.

The uniformity of the resulting emulsion was determined by collecting samples at 20-foot intervals along the hose. These were placed in tight containers, and subsequently tested for carbon disulphide content through the courtesy of Dr. E. J. Miller, of the Michigan State College Agricultural Experiment Station, Chemical Section. The tests indicated a uniform concentration of carbon disulphide throughout the length of the hose.

The characteristics of the application of water to the soil by means of a porous canvas hose have been previously determined through its use in irrigation. It has been found that the distribution along the hose line is comparatively uniform over considerable variations in elevation and soil conditions. Sidewise from the hose line, the distribution is usually uniform from two to four feet. Since irrigation water applied to a properly-drained soil quickly adjusts itself by raising the moisture to its field capacity (3), excessive concentration of the emulsion is not probable.

By this method it is possible to apply carbon disulphide emulsion at the rate of 2½ gallons per square foot to an area of 600 square feet per hour of actual operation, using one 200-foot length of porous hose. At 50–60 degrees F., soil temperature, this requires 142.5 cc. of solution and

25 gallons of water per minute. It is possible with the equipment described to increase the number of lines of hose and treat a larger area at one time, without changing the proportions, and it is also possible to change the proportions to meet different requirements.

The cost of application is lower than any which has come to our attention. The pump, relief valve, and the metering valve were designed and constructed by the authors at a nominal cost. Canvas hose can be made at present for about four cents per linear foot. Therefore, the apparatus was assembled with comparatively little expense.

This preliminary work would indicate that it is entirely possible to efficiently and economically treat large areas of soil with liquid insecticides, fungicides, and soluble fertilizers by introducing the active ingredient into the water supply in the proper dilution and to distribute it through a porous hose. The utilization of any one of several types of injecting devices is possible. The essential requirements are a fairly uniform water supply and an accurate metering valve to control the injection. The balance between the water supply and the solution must be maintained within a small margin to insure a uniform distribution of the active ingredient. The flexibility in the capacity of the injection apparatus permits the simultaneous treatment of larger areas than those mentioned. In fact, if the water supply is available, data obtained by this Station in using the hose in irrigation shows that one man can handle 1000 feet of hose, treating soil at the rate of 160 gallons per minute.

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A VISIT TO PYRETHRUM FIELDS OF DALMATIA

By Albert Hartzell

Abstract

An account is given of a visit made in August, 1932, to Dalmatia and the pyrethrum industry of that country is briefly described. Proposed measures to improve the quality of the product are reviewed.

A desire to obtain first hand information regarding the production of pyrethrum, now so generally used as an insecticide, was the motive that induced the writer to visit Dalmatia. Unfortunately only a short time could be devoted to this trip as the occasion for being in Europe was to attend the Fifth International Congress of Entomology at Paris. Leaving Venice on August 9, it was a 6 hours' ride by rail to Fiume on the eastern shore of the Adriatic Sea. The Rečina River, a tiny stream, forms the Italian-Yugoslav boundary between Fiume, formerly a free state but now under Italian control, and Sušak. Upon arrival in Sušak we presented our letter of introduction to "Putnik," the government travel and trade bureau, from its New York Office. As very little pyrethrum is grown in this vicinity arrangement was made to go by steamer to Split, in Dalmatia, with Mr. Stephan Čečuk, government agricultural agent, in charge of pyrethrum production and control.

The east coast of the Adriatic is deeply indented with estuaries and there are numerous islands. As the weather was favorable the steamer threaded its course in the quiet blue water within sight of the summit of the mountains along the coast. The colorful but barren waste of the mountains and the almost oriental atmosphere of the ports of call made us aware that we were approaching the gateway of the East.

Dalmatia is no longer a political unit but the name is applied to the greater part of the coast of Yugoslavia. It is a narrow strip of country approximately 200 miles long, 35 miles wide at the north, and tapering to a point at the south. It comprises roughly the Adriatic water-shed and as the Dinaric Alps are near the sea it gives the country its shoe-string shape. In area it is nearly the same size as Connecticut. The average temperature is from 57° to 63° F. The rainfall varies, being heaviest in the south, but in the region where most of the pyrethrum is grown the annual precipitation averages about 30 inches, confined chiefly to the fall and spring. The summers are hot and dry and there is an abundance of sunshine. The great mass of the people speak Serbo-Croat but we found little difficulty in making ourselves understood with German. The people are tall and are said to be descendants of the ancient Illyrians with Avar and Slav mixture. The eastern Adriatic has been held suc-

cessively by Rome, Venice, Turkey, Italy, Austria, and finally since 1918 by Yogoslavia. The frequent political changes have retarded its progress agriculturally. Practically all the familiar place names have been changed and Slavonic ones substituted. On the map (Fig. 47) the names

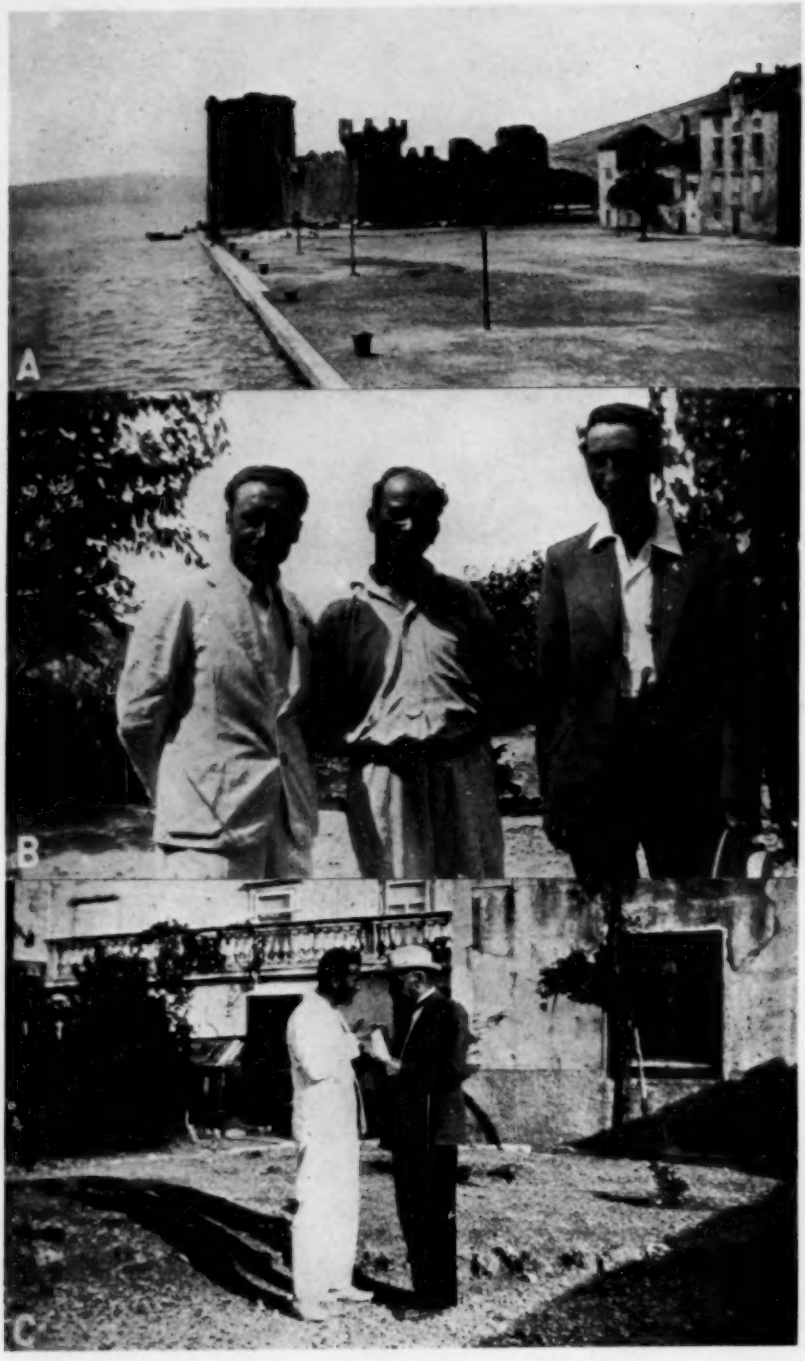
FIG. 47.—Map of the Dalmatian coast.

formerly used when the country was a part of the Austria-Hungarian empire appear in parentheses.

On arrival at Split we were met at the landing by Mr. Stanko Gučić and Mr. Alfred Fey, representative of the W. T. Rawleigh Company, exporters of pyrethrum. Split, formerly called Spalato, is a city of nearly 50,000 inhabitants and is the main seaport of Yugoslavia. Accompanied by Mr. Čečuk and Mr. Fey we visited the Agricultural

A. Pyrethrum field near Trogir, photographed in August. The plants will flower the succeeding May and June. B. Field of pyrethrum in bloom. Photographed by S. Čečuk. C. Pyrethrum flowers. Photographed by S. Čečuk.

Plate 26



A. View of Trogir, a Dalmatian pyrethrum center. B. Left to right, Mr. Stephen Čečuk, government agent in charge of pyrethrum production and exportation control; Mr. Peter Novak, station entomologist; and Mr. Alfred Fey, representative of the W. T. Rawleigh Company, exporters of pyrethrum. C. Mr. Čečuk and Mr. Halbärth with the latter's pyrethrum mill in the background.

Institute and Experiment Station. The departments include Chemistry, Plant Pathology, Soils, and Entomology. The chemical work is mainly centered on analyses of wine and olive oil. A new laboratory for pyrethrum analyses is contemplated for Mr. Čečuk. We examined the experimental plots where selection tests are under way to improve the quality of pyrethrum. Mr. Peter Novak, the station entomologist, showed us the insect collection including a fine series of cave *Coleoptera*. Nor did we fail to visit the famed ruins of the Palace of Diocletian, dating from the third and fourth centuries A.D., the walls of which enclose an area of nearly ten acres in the center of the city, now occupied largely by dwellings housing 3,000 people. Diocletian will be remembered as the Roman emperor who voluntarily abdicated the throne and is said to have written his colleague that he preferred growing cabbages in his native Dalmatia to being emperor at Rome!

The agricultural assets of this country are not at first apparent as from the sea Dalmatia appears to be a barren waste. Inland, however, we find fertile soil but the distribution is very irregular, no large contiguous areas being under cultivation. This hidden nature of the country was very forcibly brought to our attention by an auto trip to Trogir, a pyrethrum center about 25 km. from Split. The country is of limestone formation. The agriculture is primitive with scattered plantings and the surface so irregular as to be unsuitable for the employment of machinery. Oxen and donkeys are the common beasts of burden. The dominant tree is the rock pine (*Pinus maritima*) but the forested area of Yogoslavia lies farther inland. One sees grapes and olives in abundance. Figs, almonds, peaches, vegetables of all kinds, lavender, and various medicinal plants are grown. The famous maraschino cordial is made from cherries native to this country. Casava grows wild. Everywhere one sees sheep and cattle.

At Trogir we met several of the growers and visited the pyrethrum fields. The best pyrethrum is grown at an elevation of about 300 feet above sea level on limestone soil. Pyrethrum (*Chrysanthemum cinerariaefolium*) is a biennial and blooms in May and June (Pl. 25, B and C) so that the fields visited will not bear until next year (Pl. 25, A). At that time the plants were six inches in height, while the mature plant attains a height of about two feet. The pyrethrum rotation commonly practiced by the growers is as follows: pyrethrum, two years; maize, one year; wheat, one year; beans, one year. The growers received about ten dinars per kilo for last year's crop or about ten cents per pound. We visited a pyrethrum warehouse and a mill where the pyrethrum flowers were ground by two large millstones rotating in a hopper, the power being furnished by a

gasoline motor. The product of this mill was packed for the retail trade (Pl. 26, A and C).

Dalmatia produces approximately one-tenth of the world's supply of pyrethrum. Split exports about 700 tons per year which constitutes the major part of the foreign shipment.

The Yogoslav Government is making an effort to improve the quality of the pyrethrum exported,[1] by developing better technique in drying, storing, and baling. Ultimately it is planned that all Dalmatian pyrethrum offered for export will bear a government certificate of inspection based on pyrethrin content and biological analysis. Extension work is being undertaken among the growers to demonstrate the proper method of curing and handling. The method as practiced by the more progressive growers consists in picking the flowers by hand when fully opened. They are dried for not more than a day in direct sunlight after which they are dried in the shade. The flowers are baled so that parts of the inflorescence do not sift out and the bales are covered with burlap. It is necessary to overcome a tendency on the part of some growers to over-dry the flowers, as long exposure to ultra-violet light destroys the pyrethrin content.

As we left Split by rail enroute to Prague, via Zagreb, modern except for its colorful peasant costumes, we could not help but feel very grateful to our host, Mr. Čečuk (Pl. 26, B), for the courtesies extended to us while in Dalmatia and also to Captain C. Yoximovic of the Yugoslav Trade and Tourist Information Office for his letter of introduction. The policy of the Yugoslav Government in still further improving the quality of pyrethrum certainly deserves the encouragement of every one interested in insecticides.

[1]Office for Foreign Trade, Ministry of Commerce and Industry of the Kingdom of Yugoslavia, letter of October 17, 1932.

THE CHEMICAL RELATIONSHIP BETWEEN CERTAIN INSECTICIDAL SPECIES OF FABACEOUS PLANTS

By R. C. ROARK, *Insecticide Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.*

ABSTRACT

Certain insecticidal species of plants representing six genera of the family Fabaceae contain constituents that are closely related chemically. Rotenone is found in *Cracca*, *Derris*, *Lonchocarpus*, *Millettia*, *Mundulea* and *Ormocarpum*. Deguelin, an isomer of rotenone, and tephrosin, a hydroxydeguelin, are found in *Cracca*, *Derris*, and *Lonchocarpus*. Toxicarol is found in *Cracca* and *Derris*. Other constituents of minor insecticidal value are also found in these plants.

The family Fabaceae (also called Leguminosae or Papilionaceae) contains three genera, many species of which have been found to possess remarkable insecticidal properties. These are *Derris* Lour. (more properly termed *Deguelia* Aubl.), *Lonchocarpus* and *Cracca* (= *Tephrosia*). Three other genera of this family, namely *Millettia*, *Mundulea* and *Ormocarpum* are reported to contain rotenone, the most potent insecticidal constituent of *Derris* and *Lonchocarpus*.

The following table lists those species of these six genera that have been found to have insecticidal action.

DISTRIBUTION OF THESE PLANTS.—The genus *Cracca* (*Tephrosia*) includes more than 200 species growing in Africa, Australia, North and South America. Many of these are used as fish poisons. *C. virginiana*, the only species in the table growing in North America, occurs from southern New Hampshire to Florida and west to Minnesota and eastern Texas. This is a perennial herb, 10 to 12 inches high, characterized by an extensive and tough root system.

Members of the genus *Deguelia* (*Derris*) are mostly vines that climb over adjacent trees. The species listed all grow in eastern Asia and are strictly tropical. Species of *Lonchocarpus* are shrubs or trees. Cube root (*L. nicou*) is obtained from a small tree about 8 to 10 feet high. This genus is represented by African and Australian species but is especially abundant in South and Central America.

Millettia, *Mundulea* and *Ormocarpum* are tropical trees growing in Asia. Of the species listed in Table 1 those of *Cracca* seem best adapted for cultivation in the continental United States.

The content of active principles in these plants ranges on the basis of air-dry plant material from a few tenths of 1 per cent in the leaves of *C. vogelii* to more than 10 per cent in the roots of *Derris* and *Lonchocarpus*. Samples of cube root examined in the Insecticide Division of the Bureau of Chemistry and Soils have contained as high as 11 per cent rotenone.

TABLE 1. CONSTITUENTS OF CERTAIN INSECTICIDAL FABACEOUS PLANTS CLASSIFIED BOTANICALLY

Species and insecticidal part of plant	Constituents	First isolated in pure form from this species by	Insecticidal action of the plant first recorded by
Tephrosia hookeriana Wight and Arn. seeds	Unknown	———	Tattersfield and Gimingham (36) in 1932
Cracca macropoda (Harv.) Kuntze roots	Unknown	———	Tattersfield and Gimingham (35, 36) in 1927 and 1932
Cracca toxicaria (Sw.) Kuntze roots	Toxicarol	Clark (5, 8) in 1930	Tattersfield and Gimingham (35) in 1927
	Deguelin	Clark (5, 6) in 1930	
Cracca virginiana L. roots	Rotenone	Clark (9) in 1932	Little (23) in 1931
	Tephrosin	Clark (9) in 1932	
	Dehydrorotenone	Clark (9) in 1932	
Cracca vogelii (Hook.) Kuntze leaves	Tephrosin	Hanriot* (19) in 1907	Tattersfield, Gimingham and Morris (37) in 1925
	Deguelin	Clark (5, 6) in 1930	
Cracca vogelii (Hook.) Kuntze seeds	Tephrosin	Merz (26) in 1932	Tattersfield, Gimingham and Morris (37) in 1925
	Deguelin (?)	Merz (26) in 1932	
	Dehydrodeguelin	Merz (26) in 1932	
Derris chinensis Benth. roots	Rotenone	Nagai (27) in 1902	———
Derris elliptica (Wall.) Benth. roots	Rotenone	Lenz (22) in 1911	Oxley (28) in 1848; McIndoo, Sievers and Abbott (24) in 1919
	Deguelin	Clark (5, 6) in 1930	
	Tephrosin	Clark (5, 7) in 1930	
	Toxicarol	Clark (5, 8) in 1930	
	Dehydrodeguelin	Clark and Keenan (11) in 1932	
	Dehydrotoxicarol	Clark and Keenan (11) in 1932	
Derris heptaphylla (L) Merr. roots	Unknown	———	Merrill (25) in 1926
Derris malaccensis Prain roots	Rotenone	Spoon (31) in 1931	Gater (14) in 1925
	Tephrosin	Spoon (33) in 1932	
	Toxicarol	Spoon (33) in 1932	

Derris philippinensis Merr. roots	Unknown	———	Castillo (4) in 1926
Derris polyantha Perkins roots	Rotenone	Georgi and Teik (16) in 1932	Castillo (4) in 1926, and Merrill (25) in 1926
Derris thyrsiflora Benth. roots	Unknown	———	Gater (14) in 1925
Derris uliginosa (Roxb.) Benth. (= *D. trifoliata* Lour.) roots	Anhydroderrid†	Power (29) in 1902	McIndoo, Sievers and Abbott (24) in 1919
	Rotenone	Blackie (1) in 1932	
Lonchocarpus latifolius H. B. K. seeds and pods	Unknown	———	Tattersfield and Gimingham (36) in 1932
Lonchocarpus nicou (Aubl.) DC. (cube root)	Rotenone	Geoffroy (15) in 1895	Geoffroy (15) in 1895
	Deguelin	Clark (5, 6) in 1930	
	Tephrosin	Clark (5, 7) in 1930	
	Isotephrosin	Clark and Claborn (10) in 1932	
Lonchocarpus sp. (nekoe roots)	Rotenone	Spoon (32) in 1931	———
	Deguelin	Spoon (32) in 1931	
	Tephrosin	Spoon (32) in 1931	
Lonchocarpus sp. (roots and stems of white haiari)	Rotenone	Tattersfield, Gimingham and Morris (38) in 1926	Tattersfield, Gimingham and Morris (38) in 1926
Lonchocarpus sp. stems of black haiari	Rotenone	Tattersfield, Gimingham and Morris (38) in 1926	Tattersfield, Gimingham and Morris (38) in 1926
Milletia taiwaniana Hayata roots	Rotenone	Kariyone, Atsumi and Shimada (20) in 1923	———
Mundulea suberosa Benth. stems, seeds and pods	Rotenone	Greshoff (18) in 1899	Tattersfield and Gimingham (36) in 1932
Ormocarpum sp.	Rotenone	Greshoff (18) in 1899	———

*Hanriot's "tephrosine" was impure (m.p. 187° instead of 198°) and probably was mixed with deguelin.
†Anhydroderrid (m.p. 212–213°) was probably a dehydro derivative.

TABLE 2. CONSTITUENTS OF CERTAIN INSECTICIDAL FABACEOUS PLANTS CLASSIFIED CHEMICALLY

Constituent	Found in	First isolated by	Insecticidal properties of the pure compound first reported by
Rotenone, $C_{23}H_{22}O_6$, colorless crystals, melting at 163°C.	*Cracca virginiana*	Clark (9) in 1932	———
	Derris chinensis	Nagai (27) in 1902	———
	Derris elliptica	Lenz (22) in 1911	Davidson (12) in 1930 and Shepard and Campbell (30) in 1932
	Derris malaccensis	Spoon (31) in 1931	———
	Derris polyantha	Georgi and Teik (16) in 1932	———
	Derris uliginosa	Blackie (1) in 1932	———
	Lonchocarpus nicou	Geoffroy (15) in 1895	Geoffroy (15) in 1895
	Lonchocarpus sp. (Haiari)	Tattersfield, Gimingham and Morris (38) in 1926	Tattersfield, Gimingham and Morris (38) in 1926
	Lonchocarpus sp. (Nekoe)	Spoon (32) in 1931	———
	Millettia	Greshoff (18) in 1899	———
	Mundulea suberosa	Greshoff (18) in 1899	———
	Ormocarpum	Greshoff (18) in 1899	———
Deguelin, $C_{23}H_{22}O_6$, pale green crystals, melting at 171°C.	*Cracca toxicaria*	Clark (5, 6) in 1930	———
	Cracca vogelii	Clark (5, 6) in 1930	———
	Derris elliptica	Clark (5, 6) in 1930	Davidson (12) in 1930 and Shepard and Campbell (30) in 1932

	Lonchocarpus nicou	Clark (5, 6) in 1930	———
	Lonchocarpus sp. (Nekoe)	Spoon (32) in 1931	———
Tephrosin, $C_{23}H_{22}O_7$, colorless crystals, melting at 198°C.	*Cracca virginiana*	Clark (9) in 1932	———
	Cracca vogelii	Hanriot (19) in 1907	———
	Derris elliptica	Clark (5, 7) in 1930	Davidson (12) in 1930 and Shepard and Campbell (30) in 1932
	Derris malaccensis	Spoon (33) in 1932	———
	Lonchocarpus nicou	Clark (5, 7) in 1930	———
	Lonchocarpus sp. (Nekoe)	Spoon (32) in 1931	———
Toxicarol, $C_{23}H_{22}O_7$, greenish-yellow crystals, melting at 219°C	*Cracca toxicaria*	Clark (5, 8) in 1930	———
	Derris elliptica	Clark (5, 8) in 1930	Davidson (12) in 1930 and Shepard and Campbell (30) in 1932
	Derris malaccensis	Spoon (33) in 1932	———
Dehydrodeguelin, $C_{23}H_{26}O_6$, melting at 233°C.	*Cracca vogelii*	Merz (26) in 1932	Not tested
	Derris elliptica	Clark and Keenan (11) in 1932	
Dehydrotoxicarol, $C_{23}H_{20}O_7$, melting at 235–236°C.	*Derris elliptica*	Clark and Keenan (11) in 1932	Not tested
Isotephrosin, $C_{23}H_{22}O_7$, melting at 252°C.	*Lonchocarpus nicou*	Clark and Claborn (10) in 1932	Not tested
Dehydrorotenone, $C_{23}H_{20}O_6$, melting at 224°C.	*Cracca virginiana*	Clark (9) in 1932	Shepard and Campbell (30) in 1932

The amount of rotenone and other insecticidal constituents in these plants varies greatly according to the species and maturity of the plant, the nature of the soil in which grown and other factors.

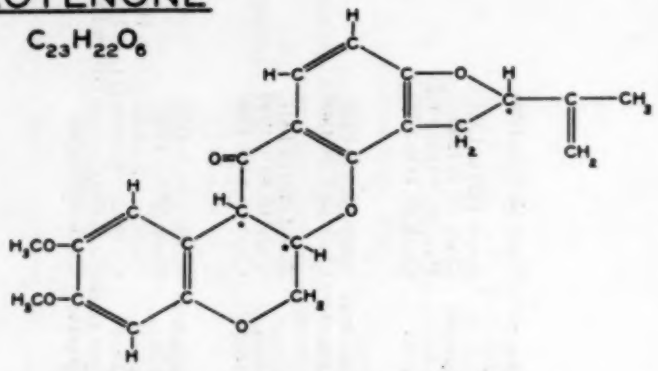
A chemical classification of the constituents of these plants is shown in Table 2.

The complete structural formulae of rotenone, deguelin and tephrosin are now known as the result of investigations by LaForge, Haller and Smith (21), and by Clark (5–10).

Rotenone is represented by the following formula:

ROTENONE

$C_{23}H_{22}O_6$



The relative toxicity to goldfish of these compounds has been determined by Gersdorff (17) to be:

Rotenone	toxicarol	deguelin	tephrosin
1	0.65	0.56	0.23

A concentration of 0.075 mg. rotenone per liter (1 part in about 13,000,000) at 27° C. kills goldfish in two hours.

When sprayed upon the bean aphid (*Aphis rumicis*) as an aqueous suspension without soap or other wetter or spreader, Davidson (13) found the order of toxicity to be, roughly:

Rotenone	deguelin	tephrosin	toxicarol
400	40	10	1

Shepard and Campbell (30) tested these compounds by the leaf-sandwich method of Campbell and Filmer (3) as modified by Campbell (2) on fourth instar silkworms and found the following order of toxicity:

Rotenone deguelin tephrosin toxicarol

The median lethal dose of rotenone in these tests was approximately .003 mg. per gram of bodyweight or 1/30 that of acid lead arsenate.

Both Davidson and Shepard found rotenone more toxic than nicotine to *Aphis rumicis*. The toxicity of deguelin and nicotine has not been directly compared but judging by the concentrations at which deguelin is effective, it is almost certainly more toxic than nicotine.

Dehydrodeguelin, dehydrotoxicarol and isotephrosin have not been tested for their insecticidal action. Dehydrorotenone was found by Shepard and Campbell (27) to be less than 1/100 as toxic as rotenone as a stomach poison to silkworms.

The genera in which rotenone and related compounds occur comprise several hundred species. It is believed that experimenters testing these species will be well rewarded by the discovery of insecticidal constituents.[1]

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[1]Since this manuscript was prepared (August, 1932), rotenone or related compounds have been found in the following additional plants by members of the Insecticide Division: *Derris grandiflora*, *Lonchocarpus guatemalensis*, *L. velutinus*, *Polygonum* (?) *sp.*, *Spatholobus roxburghii* (Jones, Jour. Amer. Chem. Soc. 55: 1737–1738, 1933), *Tephrosia candida*, *T. cinerea* and the following as yet unidentified plants: Cipo, berberra seeds, bejuco de gusano (possibly *Lonchocarpus hondurensis*), barbasco root, sopilote wood and la meh seeds.

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Section of Plant Quarantine and Inspection

Wednesday Morning Session, December 28, 1932

The meeting of the Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists convened at 10:20 a. m., in the Viking room of the Chalfonte Hotel, Atlantic City. Mr. W. A. Price, Chairman of the Section, presided.

The Chairman appointed the following committees:

Resolutions: A. F. Burgess, Chairman, E. L. Chambers and C. H. Hadley.

Nominations: G. M. Bentley, Chairman, and W. E. Britton.

ADDRESS OF THE CHAIRMAN

By W. A. PRICE, *Lexington, Ky.*

It gives me great pleasure to appear before this group and it is with the profoundest recognition of the importance of the plant quarantine work that I address you. I need not call to your attention the fact that we are just now passing through a crisis such as we have not experienced in the history of our work. Fortunate it is for us that our predecessors have laid the foundations of quarantine control well and the accumulated momentum of their efforts, so to speak, will assist in carrying us far, we hope, through this present crisis. However, we dare not rely on this good fortune, but we must be vigilant and untiring in directing our energy into those channels where the most good will be accomplished.

As your chairman I wish to make a plea to you for close and keen discrimation as to the relative merits of the different phases of our work. Important as all phases of quarantine control are, the present situation forces us to be selective. Many of you, in fact most of you, have suffered a reduction in budgets in the past months. Reduced budgets mean reduced service. Let us be wise, let us see big issues, in order that our work may suffer as little as possible.

Cramped as we are for funds locally, we have had added burdens placed upon us. Reduction in government appropriations for regulatory work has forced the lifting of some federal quarantines entirely and has greatly reduced the extent and activity of others. No one will question the fact that a quarantine placed and operated by the Federal Government is much more satisfactory than any maintained by one of several states. Reduced revenue however, forced the Quarantine Bureau at Washington to consider where they could most wisely spend the funds available. The lifting of quarantines in certain areas has placed the

burden on the states of those areas. Each state must act as a unit in attempting to check the spread of insect pests and plant diseases. In the early history of regulatory work it was essential that there be the closest harmony between the various agencies of the Federal government and the states. The smoothness with which the system has worked has almost caused us to forget that that cooperation had to be established in the beginning. Unless there is such close cooperation between the agencies and between the states many hardships will result to dealers, shippers and growers.

With the lifting of Federal quarantines many states will resort to the placement of embargoes as this seems to be the simplest, cheapest and most effective means of preventing diseases and insects from entering restricted areas. The mere announcement of such embargoes makes the shipment of host plants from an infested area into a restricted one a violation of the law. Certificates are neither issued nor recognized. The burden is placed entirely upon the people in the embargoed states. It is not necessary to say that promiscuous use of embargoes placed upon the necessities of life is not only impracticable but almost impossible. When we restrict the shipment of commodities we at once enter the field of economics. Prices are affected because of limited markets. Before any embargo is placed upon any commodity careful and thoughtful consideration should be given to the matter. The idea is to keep out the harmful disease or insect rather than the commodity.

Frequent and careful inspection of regularly established nurseries and nursery stock must be continued. Able inspectors trained in entomology and plant pathology must be retained in the service. Every state must do this not only to protect its own citizens and its own nurserymen but to protect neighboring states and to insure the recognition of its own certificates.

No doubt, in many states with reduced budgets the question of how a high standard of inspection may be maintained, has arisen. It is my belief that an inspection fee system is very satisfactory. Firstly, it furnishes needed revenue at a nominal cost to the nurseryman. Secondly, it has an excellent psychological effect. Each nurseryman under such a system feels he is a shareholder in the business. A service has been rendered to him for which he has paid and he holds his credentials. He has an interest in promoting the business and in demanding that it render him a high type of service. He is zealous in his demands that all other nurserymen or vendors of nursery stock be held to the same standards which he maintains. When the service is apparently free to him this wholesome feeling is often entirely lacking. Practically all

good nurserymen have come to realize that the system of inspection was established for them and that a rigid enforcement has been to their best interest and to that of their customers. The amount of revenue to be derived under the fee system depends upon the size of the fee charged and upon the number of nurserymen in any state. It is probably advisable in most states to have a moderate fee supplemented by state appropriation.

Sullivan in his address before you a year ago spoke at some length about the problems that have grown with the development of improved highways and the trucking business. He stated that it is not at all uncommon for truck-loads of plants and plant parts to be transported halfway across the continent. One phase of this problem is giving us more anonyance in Kentucky at the present time than any other relating to inspection work. The great number of estates of very wealthy persons in the Blue Grass area creates a demand for expensive ornamental planting on a large scale. One of the most popular shrubs about these estates is the old-fashioned boxwood. We all know that boxwood is extremely slow of growth and therefore if purchased from a nursery is usually relatively small. Now it seems that boxwoods of very large size and beautiful proportions can be obtained in some of our neighboring and nearby states, at a much lower price than that at which nurserymen can furnish them. Independent truckmen knowing of this supply and demand have engaged in a business both simple and lucrative. Often a single plant will sell for three or four hundred dollars. The boxwoods and some other stock which is gathered up promiscuously are transported by truck over improved highways. These shrubs do not come from nurseries and are not sold by nurserymen. They are therefore uninspected and capable of disseminating injurious insect pests and plant diseases.

I have reason to believe that there are states, other than Kentucky, to which such shrubs are being transported and I have no doubt many of you are facing the same problem. It is not at all uncommon to meet groups of several trucks, bearing foreign license plates and loaded with these large shrubs, traveling over our highways. Whither they are going we know not. What is the solution? Will it mean inspection at point of entry for every state? With these itinerant truckmen peddling stock from door to door it is difficult for any agent to render an inspection. Such peddlers have no terminal point. They have no place of business. It is, no doubt, fortunate that our regularly licensed nurserymen are interested and have informed us frequently of the presence of these vendors. I need not say to you that the enforcement of the nursery

inspection law under these conditions is most irregular and unsatisfactory. Undoubtedly the complications arising from the transportation of plants over improved highways will constitute one of our biggest problems in the future.

THE PRESENT STATUS OF THE GIPSY MOTH

By A. F. Burgess, *Greenfield, Mass.*

The gipsy moth program as it has been dealt with for the last 25 years has had for its purpose the prevention of the spread of this insect throughout the United States. An examination of the literature and the reports that have been received from many foreign entomologists, as well as specialists sent to foreign countries to study this insect, indicate that it has a wide range of distribution and there seems to be no doubt that it could survive and become a destructive pest in nearly all sections of the United States.

The work that has been carried on by the United States Department of Agriculture has been in close cooperation with the infested States and is based upon the premise that in case of an introduced insect which occupies only a small area and is likely to cause tremendous damage, the expenditures for control and prevention of spread should be shared by the States and the Federal Government.

For the first few years during which there was Federal participation in this work, the utmost efforts were expended by the Government and the infested States to reduce the tremendous infestation that had built up in the residential sections of the infested area and in woodland areas adjacent to travelled roads, in order to prevent the spread to uninfested territory.

In 1913, after the plant quarantine act was passed, a system of inspection and certification of products and materials likely to carry infestation was developed and has been in effective operation since that time. In fact very few cases have been found during the last 20 years where new infestations in outside territory could be directly traced to material that had been moved from the territory under quarantine. This in itself is an unusual showing and should be conclusive evidence of the value of this feature of the work.

About the time the Federal quarantine became effective a rearrangement was made of the field work on this insect and the plan adopted has been followed with some modifications since that time. It was arranged that the Federal field work would be confined to the outside

border of the infested area for the purpose of determining the extent of infestation and where the pest was spreading, and to clean up the infested areas that were discovered. The efforts of the States would be confined to the territory within this outer border and would be administered for the purpose of reducing the infestation for the protection of their own citizens and to assist in preventing further spread. This made it possible to determine from year to year the area that should be placed under quarantine and to improve the conditions of infestation in the territory that had been longest infested so as to minimize the danger of transmission of the insect on products that might be shipped therefrom.

For a number of years the infestation was so severe and the infested territory extended so rapidly that it was impossible to secure effective control with the funds that were available. After it was demonstrated that one of the principal means of spread was due to newly hatched caterpillars being carried by the wind, it became evident that another important feature had to be considered in planning the work to prevent spread.

In 1920, a heavy infestation was found near Somerville, New Jersey, and as this was an isolated colony cooperative effort was begun by the Federal Government and the State to effect its extermination. This developed into one of the largest projects of its kind that has ever been attempted and owing to the effective cooperation, ample financial backing and the united effort of a trained personnel, extermination is believed to have been accomplished. An area of over 400 square miles which was found to be infested has been cleaned up and this together with the territory surrounding it made necessary the examination of over 2300 square miles before the result was accomplished.

In 1922, several colonies of the gipsy moth were found in New York State directly west of the Massachusetts line. This was the result of rather constant spread from year to year which was impossible to prevent with the funds available to examine and treat an ever increasing border. A conference was held in Albany in November of that year which was attended by representatives from all of the infested States and those adjoining, officials from the Department of Agriculture at Washington and the Entomological Branch of Canada, and as a result of a thorough discussion of the subject a plan was evolved for establishing a barrier zone about 30 miles wide extending from the Canadian border to Long Island Sound bounded on the west by the Hudson River, for the purpose of cleaning up infestations in this area and keeping it free from reinfestation in order that the westward spread of the pest

might be prevented. This zone has been operated for the past ten years and many infestations have been exterminated within its boundry. Large areas of territory have been examined at various times adjoining the zone to the west and only two or three small sporadic infestations have been found and these have been promptly exterminated.

The Entomological Branch of the Department of Agriculture of Canada have carried on scouting work at various times in the territory adjoining the International Line and a single infestation was found in 1924 in the township of Lacolle, which is directly north of Rouses Point, New York. This infestation was promptly cleaned up and no further infestations have been found on the Canadian side of the border.

Since 1927, attention has been called to the fact that gipsy moth infestation was building up gradually east of the zone and the need for some protective work in that area has been repeatedly stressed. During the last fiscal year conditions in the zone in Vermont have shown improvement but in a group of towns in southwestern Massachusetts and northwestern Connecticut the insect has continued to persist in spite of continued efforts to control it. From the location of the new colonies that have been found it is evident that there has been considerable wind spread into the zone from territory to the eastward and this condition which was predicted some years before, has made the maintenance of the zone increasingly difficult.

Field work in the zone has been carried on in New York State in the territory south of Fort Ann by the State Department of Conservation, the remaining territory in northern New York and in the adjoining New England States being done by the Bureau of Plant Quarantine. In the entire area there are approximately 3,000,000 acres of woodland. Up to the present time about 2,000,000 acres have been scouted and infestation has been found only in the southwestern Massachusetts and northwestern Connecticut areas and in several locations directly west of it in New York State. There remains about 1,000,000 acres which should be scouted in order that this project may proceed with reasonable assurance of success.

Owing to the drastic reduction in funds for the present fiscal year all scouting of woodland areas in the barrier zone have been abandoned and in July, when a new infestation was discovered near Pittston, Pennsylvania, it was necessary to divert a large proportion of the funds from the barrier zone project in order to start work in that region. It will be impossible to do the work that is urgently needed in the worst sections of the barrier zone during the present year and the danger of increase and spread of the insect is imminent.

During the past 10 years several small infestations have been found on Long Island. Most of the control work there has been done by the State of New York but at various times scouting has been carried on by the Federal force when New York funds were not available for that purpose. In the Fall of 1929, a serious colony was found near North Roslyn, Long Island. Scouting and clean up work was carried on temporarily by the Federal forces and later, after State funds were available this work was taken over by the State Conservation Department. Progress is being made in cleaning up this infestation although some additional work remains to be done. Material likely to carry infestation is being inspected and certified by Federal inspectors before it moves from the area.

The gipsy moth problem in Pennsylvania centers around the city of Pittston in the Wyoming Valley. Work has been taken up cooperatively with the State Department of Agriculture and the Department of Forests and Waters. $70,000 was diverted from the barrier zone work in New England for use in this area and the State furnished headquarters and storage facilities and paid some minor expenses until such time as legislative action can be secured. In September a force of 50 trained and experienced men were detailed to carry on scouting work to determine the extent of the infestation and by early November it was found that an area surrounding Pittston, embracing about 15 square miles was heavily infested. Scattered infestations were located in a territory surrounding this area of about 95 square miles. As infestations were found in some parts of the territory as far as the scouting work was carried on, it will be necessary to examine the roadways, trees on private property and along the edges of woodland, and in some sections the woodland itself, in an additional area of about 150 square miles.

The area adjoining the Susquehanna River including sections that are flooded at high water has been examined from Nanticoke to beyond the Ransom township line, and the Lackawanna River as far north as the city of Scranton. A few infestations were found on the Susquehanna River but more were discovered on or near the Lackawanna River, and in all probability further infestation will be found when work is taken up in Scranton and the territory immediately surrounding it.

It is very necessary that all infestations that can be found should be thoroughly treated before the eggs hatch in the Spring.

No quarantine has been placed on the area known to be infested but shippers of trees and plants have been notified that this material must not be moved until it has been inspected and certified. Means have been taken to check up on the movement of material from badly infested localities and action is being considered concerning the placing of a

quarantine that will safeguard the products moved and protect purchaser and the shipper.

The results that have been secured from the work attempted in the Wyoming Valley in Pennsylvania, indicate that the extermination of the gipsy moth in that region is the most practical way of handling the problem. The task is difficult on account of the general favorability of the food plants and the rugged wooded country flanking the valley. It is the most feasible way of meeting the situation and protecting the enormous forest areas of Pennsylvania and the surrounding States.

The tremendous value to the country at large that has resulted from the enforcement of the gipsy moth quarantine is not fully realized. The quarantined area in New England is the source of many kinds of plant products that are moved to all parts of the United States. It is difficult to determine the value of the products whose movement is safeguarded as a result of the inspection system that is being maintained and which for nearly twenty years has efficiently performed its function with a minimum of inconvenience to the shipper and a maximum of security for the purchasers. It is believed that several million dollars represents a very conservative value for the material that is shipped annually from the quarantined area. In planning the work for the present year very slight change was made in the amount of funds to be expended for quarantine enforcement, as this is considered to be the only means of preventing long distance country wide spread.

Under present conditions the question naturally arises what should be done to meet the situation. One of three courses could be adopted.

First: To exterminate the Pennsylvania infestation in cooperation with that State, abandon the barrier zone, and divide the small amount of money that would be available between carrying on promiscuous scouting work (which in our experience is rather ineffective) in territory located somewhere west of the present barrier zone in New York, and quarantine enforcement in the abandoned area. Under this plan the present quarantine should be extended by placing the area from the east zone line to the territory where promiscuous scouting will be done, under quarantine regulations so as to protect it from shipments from the present badly or generally infested area and to protect other sections of the United States from possible infestation from shipments that come from the abandoned territory.

Second: To carry through the extermination project in cooperation with the State of Pennsylvania, to maintain the barrier zone in cooperation with the State of New York, and continue the plan that has been effective for the past ten years in preventing the westward spread

of the pest. This plan would mean an increase in expenditures for the emergency work in Pennsylvania and an increase over present available funds to continue the plan in the zone.

THIRD: To follow through plan two and supplement it by the establishment of a protective area between the zone and the Connecticut River extending about as far north as Rutland, Vermont, in order to prevent reinfestation of the zone from the east. This plan would call for additional funds. It would also give additional protection. It is believed that if this plan for future work is adopted and necessary funds made available, sufficient work can be done so that some towns in the western border of the zone may be released from time to time and more work done in towns directly east of the zone line in the section north of Rutland. Throughout a great portion of that territory millions of trees are cut every year and sold for Christmas decorations. This means considerable expense for inspection as most of them are shipped outside the quarantined area and many of them to far distant points in the United States. By adopting this plan, as territory is released on the western side of the zone a gradual reduction of the area under quarantine could be made. This plan affords ample protection to the forest and shade tree interests of the uninfested States. It will be more expensive for a time but will result in a gradual reduction in local expenditures in the western part of the zone as territory is released.

Past experience indicates that this plan is feasible and based on the value of the interests involved is a sensible as well as economical method of protection and of preventing this perpetual drain on the natural resources of the entire United States.

Larval Parasites of the Codling Moth in the Santa Clara Valley, California.—During the past three years while conducting experimental work in codling moth control in Santa Clara County, California, several thousand mature codling moth larvae were collected from beneath bands and reared out in order to obtain eggs and young larvae for laboratory experiments. Two species of larval parasites have been reared from these several thousand larvae. The first of these is the codling moth tachinid, *Lixophaga variabilis* (Coq.) (Hypostena). This parasite has previously been reared from the same locality by J. F. Lamiman. (Unpublished thesis, University of California, 1924.) In these investigations natural parasitism by this insect was found to run as high as five per cent in some collections of larvae. The second parasite reared was hymenopteron of the family Braconidae, *Ascogaster carpocapsae* (Viereck). The percentage of parasitism by this species is very low as but a few specimens have been obtained. So far as it has been possible to determine, this is the first record of this species from the above mentioned locality.

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EXPERIENCE IN ENFORCING COMPULSORY CLEAN-UP REGULATIONS ON ACCOUNT OF THE EUROPEAN CORN BORER

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

ABSTRACT

Brief summary of three seasons' experience in enforcement of a compulsory clean-up law in Connecticut for the control of the two-generation European corn borer, *Pyrausta nubilalis* Hubn. Methods of procedure, difficulties and results are described.

The Connecticut General Assembly of 1929, as an aid in the control of the two-generation European corn borer, enacted a law requiring growers to dispose of all cornstalks, and weeds subject to infestation, before April 10 of each year, provided the Director of the Connecticut Agricultural Experiment Station issues an order to that effect. Such order is applicable only to territory under state quarantine. The States of Massachusetts and Rhode Island had enacted similar measures prior to the passage of the Connecticut law.

This measure was first enforced in 1930, when the southeastern portion and slightly less than half of the area of the state was under quarantine. Considerable newspaper publicity was given the matter explaining the law, the Director's order, and the damage caused by the borer. Four days after the time limit set, seven inspectors were sent through the area, each inspector being furnished with an automobile, and instructed to cover nine or ten towns. When any cornstalks or stubble were observed the inspector interviewed the owner or manager and filled out an order on a blank card prepared for the purpose. This card was in the form of a return postcard. The owner was asked to sign the order promising to comply on or before a certain date specified. Usually several days were allowed for the necessary clean-up. The signed card was returned to the office by the inspector and the other left with the owner to be signed and mailed as soon as the work was completed. The seven inspectors were engaged in this work for about two weeks while they covered 72 towns and issued 749 cards. Of this number 685 cards or 91.4 per cent, were returned to the office stating that the work had been completed. As this was the first attempt at enforcement no real effort was put forth to follow up the others. In some cases the writing was illegible, and education was the chief object sought. The inspectors were all Federal employees and only their expenses were borne by the state. The cost to the state was just under $400.

Federal scouts in 1930 found that many additional towns were infested so that in the spring of 1931 more than three-fourths of the state was quarantined. Notices were issued through the newspapers and 16 inspectors were sent into the field and worked about a month. The same card system was used except that the cards were numbered serially and the same number stamped on each section of the double card to facilitate identification. These inspectors visited 137 towns and issued 1,562 notices, and 1,377, or 88.8 per cent were returned stating that the clean-up work had been completed. Some of these cards were not received at the proper time and letters were sent to the growers who had failed to respond. Some 28 of these letters were returned undelivered, due perhaps to the inability of the office force to decipher the names, many of which were foreign. No other follow-up measures were practiced. The cost of this work in 1931, exclusive of supervision, was about $1,178.83.

In 1932 the insect had spread to such an extent that the Federal and state quarantines were placed over the entire state. Wide publicity was given the clean-up order. Consequently, 23 inspectors, in charge of M. P. Zappe and J. P. Johnson, were employed for about six weeks to cover the 169 towns in the state, and a re-check was made during a second visit. They used the same card system and issued about 3,750 cards, of which 3,604, or 96.1 per cent, were completed and reports returned. There were 146 that failed to report. These were nearly all again seen by the inspectors or supervisors. A large proportion had cleaned up but had lost or mislaid their cards, and claimed that they didn't know whom to address. Some others had taken no action but promised to do so at once and our men saw that the work was completed. Altogether, seven refused or neglected to take action and were reported to the prosecuting attorney or to a grand juror of the town and the men were brought into court. All were made to clean up and their action checked by the state police. Two were given small fines, and six were assessed costs. The cost of gasoline, oil and other traveling expenses together with the salaries of inspectors and supervisors for enforcing the clean-up in 1932 was $4,331.17.

In this work, clean-up was enforced only in the rural districts and no attempt was made to cover back-yard gardens in villages and cities. One frequent difficulty arose in regard to rented property. The tenant perhaps planted a field of corn and in the fall moved away leaving the cornstalks standing in the field. In such cases the owner usually felt that he was not responsible and should not be obliged to dispose of them. However, it seems to be a principle of law that in the last analysis the

owner must be held responsible for any nuisance, or for compliance with any legal regulations affecting his property. Another difficulty presents itself in case of bankruptcy proceedings, as it is sometimes necessary to issue an order to the receiver. In all prosecutions the courts gave satisfactory help and cooperation.

APPLICATION OF HORSE SENSE TO PLANT QUARANTINES

By THOMAS J. HEADLEE, Ph.D., *State Entomologist of New Jersey*

In this paper I will make no attempt to consider the regulation of insect carrying products moving across international boundary lines, not because I have information to show that such regulations are above reproach, but because I realize that my knowledge and experience are insufficient to justify me in venturing on such ground. The domestic plant quarantine, both federal and state, represents the field which I desire to consider.

SOURCE OF BASIC PRINCIPLES.—Basic principles for plant quarantine procedure are usually sought in the biological and economic aspects of the parasite organism, against which it is desired to erect barriers. With attention centered upon the organism and the harm which it can presumably do, it is easy to overlook or underestimate the effect on organized society, which will be wrought by regulations designed to prevent the spread from infested to uninfested territory. So far as known, no one has as yet worked out the full effects of any plant quarantine. Efforts have been made in a number of instances to estimate, more or less closely economic benefit and economic damage done by certain plant quarantines. No one has been much impressed with the idea that any or all of these efforts has in any case given a complete picture of what has happened.

Every quarantine equation has in it many imponderables in the way of psychological effects, the results of which are extremely difficult, if not impossible to measure. Every material disturbance of social customs, habits, and procedure has far-reaching effects.

Evidently, then in a search for basic principles of plant quarantine procedure it is not enough to study the biologic and economic aspects of the parasite organisms but any study worthy of the name must include the social factors of human psychology and activities.

QUALIFICATION OF A SITUATION FOR QUARANTINE.—From the standpoint of the parasite organism and human welfare, the following questions must be answered clearly in the affirmative or the situation does not qualify for quarantine regulations.

(1) Is the organism potentially capable of economic damage in uninfested territory under the topographic, climatic and biologic conditions obtaining therein?

(2) Is there any sound reason that gives fundamental support to the idea that it can be exterminated where once established or is there any reason or set of reasons to indicate definitely that the organism can be held to the area of present infestation?

(3) Will extermination more than counterbalance the cost of the operation and the losses to Industry and commerce the effort will entail?

(4) Will prevention of spread perform an economic service materially greater than the cost of the operation and the losses to industry and trade the effect will entail?

The only type of domestic plant quarantine in operation today, which fails to answer these questions in the affirmative, is the quarantine which claims merely to retard spread of the parasite organism. There are many examples of this type. For the operation of this type of quarantine the one-sided reason is given that a few more years of freedom for uninfested territory saves in the aggregate an enormous expense which otherwise would be visited upon the growers of the uninfested territory. The writer calls this a one-sided reason because it fails to subtract from this assumed benefit the losses due to interruption and disruption of the flow of normal legitimate business activities occasioned by the quarantine. Furthermore, the presumption of benefit is vitiated by the fact that it is predicated on the assumption that the parasite's activities will be the same in nature and degree in the uninfested territory as they have been found to be in the infested territory; an assumption not only not necessarily sound but surely unsound in some cases and very probably unsound in other cases.

It is easy for the law enforcement organization to yield to the public psychology of fear and place quarantines against the object of that fear. In fact, a man who refuses to cater to the fears of his people in these matters must be of an understanding mind and have his feet well planted. Indeed, he should, before the building up of fear takes place among his people, see it coming and turn their psychology away from it. It takes great foresight and real courage to do a thing of this sort.

State and Federal Domestic Quarantines.—Domestic plant quarantines may originate in states or in the Federal government. Plant quarantines originating in the state would naturally be supposed to regulate intrastate matters but as a matter of fact most of them seem to be concerned with interstate commerce in that they are designed to pre-

vent or retard entrance into the quarantining state of some plant parasite known to occur in territory outside the state. It seems perfectly clear then that most domestic quarantines originating with the states attempt in part to regulate interstate commerce, a field especially given over by the constitution to federal action. From various decisions of the Supreme Court, it seems that in the absence of federal action the state is free to put into force regulations affecting interstate commerce. It is presumed that the plant quarantines originating in the states and affecting interstate commerce have their legal justification in this point.

Furthermore, it is, of course, possible for a state under intrastate quarantine to interfere with interstate commerce indirectly by preventing the state consignee of the interstate moving goods from distributing the goods within the limits of the state, but concerning legality of this procedure there might be a question raised and this question might or might not be settled to the satisfaction of state quarantine authorities. Furthermore, state quarantines affecting interstate business can be avoided by the subterfuge of shipping into another state to a certain consignee and rebilling to the quarantined state.

There is no doubt that such a situation as above outlined exists now with plant quarantines originating in the states independently of federal action. Such a situation is loaded with dynamite and needs only a few hotheaded quarantine officials to set it off. Such a situation is dangerous to large and important business interests, to agricultural producers, and especially to professional entomologists everywhere.

For its own good and the good of the country as a whole, no state should put on quarantines regulating interstate commerce directly or indirectly without federal action and entomologists should see to it that nothing of this sort occurs with their concurrence and support. In fact, it seems to the writer, that the responsibility for preventing such things rests upon the state entomological officers.

Regardless of the lack of wisdom in trying merely to retard the distribution of insect species, better protective results of a character usually sought by state plant quarantines can be secured through the use of the federal tag. Goods equipped with this tag should go freely in all such regions of the United States as are specified on the tag.

Demands of Horse Sense.—The general public is tired of the state and federal quarantines that move their lines back from time to time and regards such retirement as definite confession of failure. The general public believes that public funds spent in such quarantines is wasted and is not disposed much longer to support them.

Let us consider the bearing of common or horse sense on the matter of

quarantines. Insect species are being more or less rapidly distributed over the world. The United States has already received many species and is due to receive many more. Such introductions usually, but not necessarily, start at one point. Within continental United States there is constantly going on a process of country-wide distribution of species not as yet all over. Furthermore, with species already fully distributed, there is a constant movement with commerce from one part of the county to another.

In view of this situation what kind of domestic plant quarantine regulations are logical and effective? In the first place, the quarantine which accompanies *extermination* and is necessary thereto is logical and sound. In the second place, the quarantine which actually *prevents* distribution without entailing too serious readjustments of business and agriculture is worthwhile. In the third place, the use of the United States tag with its declaration of freedom from specified species and its specification of the parts of the United States into which it may be shipped is, with present psychology, an inescapable necessity if commerce between the states is not to be seriously disrupted.

This means the abrogation of some of our present federal quarantines, the elimination of the purely state quarantines which affect interstate commerce, and a close and effective cooperation between state and federal plant parasite regulatory forces in the use of the United States tag.

Fortunately, instrumentalities are at hand for bringing about these results, which are merely the plain dictates of common sense applied to our present domestic quarantine situation. The writer refers to the Plant Quarantine and Control Administration under the leadership of Mr. Lee Strong and the National Plant Board under the leadership of Professor Walter C. O'Kane.

In face of the present plant quarantine chaos, which seems from the state angle to be increasing, I repeat that these three foundational propositions represent the least that common sense treatment of the case requires. More can hardly be expected in view of present plant pest regulatory psychology and less should not be tolerated.

REPORT OF THE CENTRAL STATES PLANT BOARD

By P. T. ULMAN, *Secretary*

The eighth annual meeting of the Central States Plant Board was held on March 4 and 5, 1932 at Wooster, Ohio. Twenty-four entomologists and inspectors were in attendance representing seven of the thirteen states comprising this section of the National Plant Board. The states represented were Ohio, Wisconsin, Kansas, Indiana, Illinois, Minnesota, Missouri. In addition E. N. Cory of College Park, Maryland, Lee A. Strong, S. B. Fracker, W. H. Larrimer and S. A. Rohwer of Washington, D. C., were present.

After a short address by the president, E. L. Chambers, a report was presented by the representatives on the National Plant Board concerning the National Plant Board meeting held in New Orleans. Dr. L. A. Strong, speaking on "Domestic Quarantines, What of their future?" reported the curtailment of work due to lack of funds and the necessity of checking financial return against expenditures.

Mr. Wallace opened the discussion on "The advisability or inadvisability of revoking or revising Quarantine No. 43 on account of the European corn borer." The subject was further discussed by Dr. Strong, Professor Dean, Mr. Sullivan, Mr. Ellenwood, Mr. Glenn, Mr. Ruggles and Mr. Rohwer. The following resolution was passed: "Be it also resolved that since Congress has failed to comply with the request of the Secretary of Agriculture to appropriate adequate funds to maintain an efficient European corn borer quarantine, that the Central Plant Board go on record as not favoring the expenditure of funds on an inefficient quarantine such as a paper quarantine would be."

After a discussion opened by Mr. Ellenwood regarding Quarantine No. 48 on account of the Japanese beetle, the Central Plant Board passed a motion "favoring the continuance of the Federal Domestic Japanese Beetle Quarantine No. 48."

Following a discussion of Quarantine No. 63 on account of the White Pine blister rust by Mr. Ruggles, Professor Dean, Dr. Strong, Mr. Glenn and Mr. Fracker, the Board went on record as recommending the retention of Federal blister rust regulations with ample revisions.

After some discussion on Quarantine No. 62 relating to Narcissus bulb pests it was recommended that the domestic quarantine be dropped.

Dr. H. C. Young, Chief of Botany in the Ohio Agricultural Station at Wooster led a discussion on state quarantines dealing with plant diseases.

The remainder of the session was devoted to minor inspection problems and to the report of committees and other matters of business.

REPORT OF THE WESTERN PLANT QUARANTINE BOARD

By A. C. FLEURY, *Secretary, Sacramento, California*

The Fourteenth Annual Conference of the Western Plant Quarantine Board was held at Bozeman, Montana, June 9th and 10th, 1932. Every courtesy to make this conference a success was extended by Mr. A. H. Safford, Montana Commissioner of Agriculture, Labor and Industry, and Mr. George L. Knight, Chief, Montana Division of Horticulture.

We were particularly honored and benefited by having with us on our program Mr. Lee A. Strong, Chief of the Federal Bureau of Plant Quarantine, who spoke on "Observations on the Present Status of Plant Quarantine Enforcement;" Mr. Wm. C.

Wood, Superintendent, Division of Classification, Post Office Department, who read a paper on "The Status of State Quarantines under the Postal Regulations Pertaining to Plants and Plant Products;" Mr. W. W. Wood, Assistant Plant Quarantine Inspector with the U. S. Bureau of Plant Quarantine, who gave a talk on "New Developments Along the Northern Border;" and Mr. E. Coppel Rivas of the Department of Agriculture of the Republic of Mexico, who spoke on the Mexican fruit fly situation in Mexico and the efforts now being directed towards the control or eradication of that pest.

A number of subjects of interest to the western states were discussed as follows:

(1) The alfalfa weevil quarantines now maintained by a number of the states was reviewed and a special committee was appointed to draw up recommendations covering possible justifiable modification in the restrictions enforced by some of the states. Later in the meeting this committee submitted a recommendation that all states comprising the Western Plant Quarantine Board modify their alfalfa weevil quarantine as regards the movement of fruits, vegetables, household goods, farm machinery and nursery stock. It was pointed out that most of the difficulties connected with the alfalfa meal situation had been clarified by practically all states now admitting meal when shipped from approved mills under proper safeguards.

(2). The potato tuber moth quarantine regulations of several of the states were discussed and it was recommended that those states maintaining such quarantines uniformly accept vacuum fumigation of potatoes as adequate treatment for elimination of tuber moth.

(3). The committee appointed to report on black walnut canker was continued for another year in order to permit them to gather more information. This same committee recommended that those western states now having a commercial or potential pecan industry take the necessary quarantine action to protect this industry against the introduction of pecan nut case bearer, the pecan leaf case bearer and other serious nut tree insects not now occurring in the west.

(4). The black locust borer was a subject of considerable discussion. It was pointed out that Idaho has placed a quarantine against this insect and it was recommended that those western states having valuable locust plantings and free from that pest should take like quarantine action.

(5). The subject of possible pest introduction through the means of rice straw and other plant material as packing from foreign countries was again reviewed and the Board again expressed itself as feeling that federal quarantine action should be taken to meet this situation.

(6). Much interest was shown by all of the states in presenting and reviewing the several pest treatment methods which have been developed during the previous year. Atmospheric fumigation with hydrocyanic acid gas for thrips on citrus fruits and vacuum fumigation with hydrocyanic acid for mealybug on persimmon fruits to meet Hawaiian regulations; vacuum fumigation of potatoes for tuber moth; the use of liquid insecticides as a dip for sour limes from Mexico infested with scale insects; the injection of various liquid insecticides under fumigation for freeing date palm offshoots from Marlatt scale; thermal treatment of pears for mealybug and all fruits and vegetables as a Mediterranean fruit fly preparedness program; and a review of the experiments under way on the treatment of bulbs with ethylene dichloride and carbon tetrachloride were discussed.

(7). The matter of apiary inspection, particularly with regard to honey certification, was discussed and it was finally recommended that the Board defer any definite

action on the matter of honey certification until such time as more definite information is had by a committee appointed for that purpose from the Bureau of Bee Culture in Washington.

Among the important resolutions adopted were the following:

(1). Requesting the Secretary of Agriculture to make provision for a systematic and basic investigation for the control or eradication of important weed species and provide for a correlation of all weed control activities within the United States.

(2). Requesting the U. S. Bureau of Plant Quarantine to call an official hearing in the near future to consider the promulgation of a federal quarantine to restrict the use of plant material as packing from foreign countries.

(3). Requesting the Secretary of Agriculture to provide for more complete enforcement of the Lacey Act directed against the introduction of injurious bird and mammal species by designating maritime port and border inspectors of the Federal Bureau of Plant Quarantine as enforcing officers of that act.

In addition to the above resolutions the following recommendations and matters were called to the attention of the National Plant Board:

(1). The desirability of having such changes made by the Post Office Department in the Postal Laws and Regulations as may be necessary to make parcel post shipments of plants and plant products amenable to the quarantine regulations of the destination state.

(2). The desirability of the U. S. Bureau of Plant Quarantine acting as the central agency to prepare a master copy of an index or schedule of plant quarantine laws and regulations of each of the states and the federal domestic quarantines for the benefit of common carrier transportation agents, with the understanding that the printing and distribution to agents of such an index shall be handled by some agency to be designated by the transportation companies, and for the U. S. Bureau of Plant Quarantine to act in a similar capacity in the case of any changes or revisions of such quarantines. This proposal originally came from representatives of the transportation companies in the west with the idea that such index or schedule should be briefed and prepared in a way that it could be readily and effectively used by transportation agents by having one page for each state on which would be listed in alphabetical order the commodities restricted entry by such state, followed by a very brief statement as to the area quarantined against and as to whether that commodity was embargoed or admitted subject to certification, treatment, etc.

The officers elected for the ensuing year are George L. Knight of Montana, Chairman; Dr. F. E. Stephens of Utah, Vice-Chairman; A. C. Fleury of California, Secretary-Treasurer; and A. C. Fleury of California to serve with George G. Schweis of Nevada as a representative to the National Plant Board.

The next meeting of the Western Plant Quarantine Board was set for some time in June, to be held at Salt Lake City, Utah.

Wednesday Afternoon Session, December 28, 1932

VAPOR-HEAT TREATMENT FOR THE CONTROL OF BULB PESTS AND ITS EFFECT UPON THE GROWTH OF NARCISSUS BULBS[1]

By F. J. SPRUIJT, *Assistant Entomologist*, and F. S. BLANTON, *Junior Entomologist*, *Division of Truck Crop and Garden Insects, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Vapor heat may be employed for the control of the bulb flies. Even the lowest temperature (110° F.) with a short time duration (three hours) was found to be ample for the control of both the larvae and pupae of Eumerus. There are indications that the Narcissus bulb nematode, *Tylenchus dipsaci* Kühn., may be killed by this method without injury to the plants. The stimulating effect upon the growth, due to a moderate treatment, is expressed in the considerable weight increase of field-grown stock, and in most cases the bulbs treated at the higher temperatures were as good as or better than the untreated checks. Bulbs that were forced in a greenhouse after being submitted to a vapor treatment at 120° F. for two hours produced flowers equal to those of untreated checks. At lower temperatures the flowering date would sometimes be slightly advanced, but not enough to be of commercial importance. The foliage was not injured by this method of treatment.

The vapor-heat treatment was first applied to narcissus bulbs during the winter of 1929–30 by E. G. Hume in Orlando, Fla., under the direction of A. C. Baker, of the Bureau of Entomology. The initial treatments of Paper White and Chinese Sacred Narcissus and of Amaryllis bulbs were made early in January, 1930. As pointed out by Latta,[2] the use of saturated heat for the control of insects was suggested by D. L. Crawford as early as 1913, when he demonstrated that hot air of high moisture content would kill the eggs and larvae of the Mexican fruit fly, (*Anastrepha ludens* Loew) in citrus fruits without being detrimental to the fruit. During the Mediterranean fruit fly campaign of 1929–30 in Florida, A. C. Baker applied and developed this method in connection with the treatment of citrus fruits and it was given commercial application by L. A. Hawkins, of the Bureau of Plant Quarantine.

[1]The portions of this work dealing with the effect of the vapor-heat treatment against the bulb nematode, *Tylenchus dipsaci*, were done in cooperation with the Division of Nematology, Bureau of Plant Industry, U. S. Department of Agriculture. The writers wish to acknowledge particularly the assistance rendered by Gerald Thorne and Edna M. Buhrer in making the examinations of all nematode infested material treated in 1931 and 1932.

[2]Latta, Randall. The vapor-heat treatment as applied to the control of Narcissus pests. Jour. Econ. Ent. 25: 1020–1026. 1932.

Because of the success in Florida of the treatment of citrus fruits and especially on account of the preliminary indications obtained in the treatment of Paper Whites and other bulbs by Mr. Hume, vapor-heat equipment was installed in two bulb-growing centers, one in the State of Washington in the Northwest and one on Long Island in the East. The equipment installed was essentially the same as that originally utilized in Florida and has been described by Latta,[2] Hawkins,[3] and Mackie.[4] The installation at Babylon, Long Island, was completed late in the season of 1930 and a series of preliminary trials, the results of which are not given here, were hurriedly made to determine its possibilities.

Effect of the Treatment on Eumerus Larvae and Pupae.—In September, 1931, a more extensive series of treatments were made at Babylon as follows: At 110° F. for 3, 4, 5, and 6 hours; at 111° for 3, 4, and 5 hours; at 112° and 113° for 2, 3, and 4 hours; at 114° for 1, 2, and 3 hours; and at 115°, 118°, and 120° for 1 and 2 hours. In each of these tests 75 healthy Narcissus bulbs of each of five varieties were treated. In addition to these healthy bulbs, bulbs containing large numbers of Eumerus larvae were included in the various lots treated. Twenty or more Eumerus pupae exposed in Petri dishes were also included to determine the effect of the heat upon their emergence. After treatment 50 bulbs from each lot of healthy bulbs were planted in the field and 25 were planted in flats and later forced in the greenhouse during the winter. The results of these tests are presented in Table 1. The fact that 100 per cent mortality was obtained in all cases shows that adequate control of the immature stages of *Eumerus* sp. can be obtained by vapor-heat treatment at 110° F. for three hours.

Effect of the Treatment on the Bulb Nematode.—Since it is the common contention among bulb growers, as well as among some research workers connected with the narcissus-bulb industry, that the so-called eelworm disease is one of the more important problems in the production of Narcissus, observations on the effect of the vapor-heat treatment on the bulb nematode, *Tylenchus dipsaci* Kühn, were included in these investigations. Since the killing effect of vapor-heat on Eumerus larvae and pupae was found to be adequate at the lower temperatures used, and since, as will be shown later, the tolerance of the Narcissus bulb to the vapor heat seemed to lie at a much higher temperature, the thermal death point of the bulb nematode should be looked for in the higher temperatures. It was believed, therefore, that the deter-

[3]Hawkins, L. A. Sterilization of citrus fruit by heat. Texas Citri. 9: 21–22. 1932.

[4]Mackie, D. B. Heat treatments of California fruits from the standpoint of compatibility of the Florida process. Calif. Dept. Agr. Mo. Bul. 20: 211–218. 1931.

TABLE 1. EFFECT OF VAPOR-HEAT TREATMENT OF NARCISSUS BULBS UPON THE IMMATURE STAGES OF EUMERUS SPP. AND THE WEIGHT INCREASE OF THE BULBS

Treatment		King Alfred bulbs						Glory of Sassenheim bulbs					
		Mortality of	Weight of bulbs					Mortality of	Weight of bulbs				
Temperature	Duration	Eumerus larvae and pupae[1]	When planted		When dug		Weight increase	Eumerus larvae and pupae[1]	When planted		When dug		Weight increase
°F.	*Hours*	*Per cent*	*Pounds*	*Ounces*	*Pounds*	*Ounces*	*Per cent*	*Per cent*	*Pounds*	*Ounces*	*Pounds*	*Ounces*	*Per cent*
110	3	100	4	14	10	7	114.1	100	2	12	6	3	125.0
	4	100	5	2	10	6	102.4	100	3	11	8	8	130.5
	5	100	5	4	10	2	95.1	100	3	8	8	8	142.9
	6	100	4	12	9	11	103.9	100	3	9	8	1	126.3
111	3	100	4	2	9	7	128.9	100	3	11	7	9	105.1
	4	100	4	1	8	0	98.4	100	3	11	7	9	105.1
	5	100	4	9	9	12	113.7	100	3	1	7	0	128.6
112	2	100	4	7	9	10	131.0	100	3	11	8	6	127.1
	3	100	4	9	9	3	115.1	100	3	13	8	10	126.2
	4	100	4	10	9	6	102.7	100	4	6	9	0	105.7
113	2	100	4	10	10	0	134.4	100	4	0	8	13	120.3
	3	100	4	7	8	15	101.4	100	4	5	9	0	108.7
	4	100	4	12	9	8	100.0	100	4	5	9	3	113.0
114	1	100	5	11	10	13	90.1	100	3	14	8	7	117.7
	2	100	5	0	10	4	105.0	100	4	4	9	6	120.6
	3	100	5	1	10	2	100.0	100	4	0	8	9	114.1
115	1	100	4	12	10	4	115.8	100	4	5	9	10	123.2
	2	100	4	13	10	4	113.0	100	3	13	8	5	118.0
118	1	100	5	0	9	10	92.5	100	4	14	10	1	106.4
	2	100	5	2	9	13	91.5	100	5	4	10	4	95.2
120	1	100	5	0	9	8	90.0	100	5	2	9	11	89.0
	2	100	5	2	10	0	95.1	100	4	14	9	6	92.3
Check		—	10	3	19	11	93.3	—	5	0	9	15	98.8

[1]In all cases 20 or more Eumerus pupae and many hundred Eumerus larvae were subjected to the treatment.

mination of the temperature lethal to *Tylenchus dipsaci* should be the guiding factor in further investigations.

Experiments in 1931.—The first samples used in the experiments conducted in 1931 were dried and shriveled bulbs that had been rogued out

TABLE 2. EFFECT OF VAPOR-HEAT TTEATMENT ON THE BULB NEMATODE, *Tylenchus dipsaci*, SEPTEMBER, 1931[1]

Treatment			
Temperature °F.	Duration *Hours*	Number of nematodes found	Condition of nematodes
110	3	Several thousand	Mostly active
	3	Several hundred	Mostly active
	4	Several hundred	Mostly active
	4	Several hundred	About two-thirds active
	5	Many thousand	Mostly active
	5	Several hundred	About 50 per cent active
	6	Several hundred	About 50 per cent active
	6	Several hundred	Mostly active
111	3	Many thousand	Mostly active
	3	Several hundred	Mostly active
	4	Many thousand	Mostly active
	4	Several thousand	Mostly active
	5	Many thousand	Mostly active
	5	Several hundred	Mostly active
112	2	Several thousand	Mostly active
	2	Several thousand	Mostly active
	3	Many thousand	Mostly active
	3	Several thousand	Mostly active
	4	Many thousand	Mostly active
	4	Several hundred	Mostly active
113	2	Several hundred	Mostly active
	2	Several hundred	Mostly active
	3	Several thousand	11 of 50 active
	3	Several hundred	11 of 50 active
	4	Several hundred	All active
	4	Several hundred	About 50 per cent active
114	1	Several thousand	About 50 per cent active
	1	Several hundred	Mostly active
	2	Several thousand	Mostly active
	2	Several thousand	Mostly active
	3	A few hundred	12 of 50 active
	3	Several thousand	About 50 per cent active
115	1	Several thousand	Mostly active
	1	Several thousand	Mostly active
	2	Many thousand	Mostly active
	2	Several hundred	Mostly active
118	1	Many thousand	Mostly active
	2	Many thousand	Mostly active
120	1	Several hundred	8 of 50 active
	2	Many thousand	7 of 50 active

[1]Examinations were made by Gerald Thorne.

of commercial plantings early in the growing season. Though heavily infested with nematodes, these bulbs were dug prematurely and had been dry for six months prior to treatment, and it is believed that the nematodes present may have gone into a dormant and therefore more resistant stage of existence. Mr. Gerald Throne, who examined the treated bulbs, reported finding great numbers of *Tylenchus dipsaci* in the pre-adult stage, the most resistant and dormant stage in the life cycle of this nematode. This condition may account for the different results obtained in the two successive years of treating nematode material, as is pointed out in the subsequent discussion.

As indicated in Table 2, exposures of as long as six hours were given in the treatments at 110° F. while in the treatments at 115°, 118°, and 120° F. the times of exposure were reduced to one and two hours. Samples treated for one and two hours at 120° F. showed 16 and 14 per cent revival, respectively. Where any doubt existed as to their mortality, 50 of the apparently dead but sound-looking specimens of nematodes were left overnight in a moist chamber at approximately 22° C. From these treatments it was concluded that a 2-hour treatment is too short to give satisfactory results, even at the higher temperatures.

Experiments in 1932.—After the uninfested treated bulbs had been grown in the field and their weight increase had been calculated, no harmful effects of the treatment could be noticed; so in the late summer of 1932 treatments were given at higher temperatures and the time of exposure was lengthened. The nematode-infested bulbs for these treatments were dug in the field during August, 1932, together with the general plantings of bulbs. In contrast to the material used in 1931, these bulbs were fresh and comparatively green, more like bulbs that the commercial bulb grower would have to handle. Following the treatments examinations for living nematodes were made by Miss Buhrer. In only four cases, at 112° F. for four and six hours and at 113° F. for three and five hours, were living nematodes found. (Table 3.) These figures apply to *Tylenchus dipsaci*. Living *Cephalobus* sp.[5] were found in bulbs exposed at 115° F. for ten hours and at 118° F. for three hours.

Effect of Treatment on the Weight Increase of Bulbs Subsequently Grown in the Field.—During the spring of 1932 field observations were made to determine the growing and flowering conditions of the bulbs that had been subjected to the various vapor-heat

[5]Where nemic forms are encountered in the examination of narcissus bulbs, the species of nematode present should be determined by a nematologist. Cephalobus may enter weakened bulbs or be associated with and follow Tylenchus, but according to present knowledge it is a weakness parasite or saprophytic in behavior.

TABLE 3. EFFECT OF VAPOR-HEAT TREATMENT ON THE BULB NEMATODE, *Tylenchus dipsaci*, SEPTEMBER, 1932[1]

Treatment		Number of bulbs in lot	Number and portion of bulbs examined	Number and condition of nematodes found
Temperature °F	Duration *Hours*			
112	4	23	1 in center	Numerous, one-half of them revived, but died in 18 hours
	5	9	1 in center, 1 in side	Fair number, all dead
	6	6	1 near center	Numerous, a few alive
	8	9	1 near center	Few, all dead
	12	12	2 in centers	Few, all dead
113	3	3	1 in center	Few, 5 out of 22 alive
	4	4	½ of 1	Few, all dead
	5	3	3	Few, 3 out of 25 alive
	6	3	3	Few, all dead
	7	4	4	Few, all dead
	8	2	1 in center	Fair number, all dead
	9	5	5	Few, all dead
	10	3	1 in center	Numerous, all dead
	11	3	2 near centers	Numerous, all dead
	12	3	1 near center	Fair number, all dead
114	3	7	1 near center	None found
	4	3	1 near center	Few, all dead
	5	4	1 near center	None found
	6	5	1 near top	Fair number, all dead
	7	5	1 near center	Fair number, all dead
	8	4	2 near centers	None found
	9	5	1 entire	Few, all dead
	10	3	1 near center	Few, all dead
	11	5	2 in centers	None found
	12	5	1 in center	Numerous, all dead
115	3	6	1 in center	Few, all dead
	4	4	1 in center	Very few, all dead
	5	4	1 in center	Very few, all dead
	6	3	1 in center	Numerous, all dead
	7	3	1 in center	Few, all dead
	8	4	1 in center	None found
	9	4	2 in centers	None found
	10	6	2 in centers	Numerous, all dead[2]
	11	7	1 near center	Numerous, all dead
	12	4	2 near centers	Few, all dead
116	3	3	2 near centers	Very few, all dead
	4	3	1 in center	Numerous, all dead
117	3	4	2 in centers	Fair number, all dead
118	2	3	2 in centers	Numerous, all dead
	3	4	1 in center	Numerous, all dead[2]
	4	3	1 in center	Numerous, all dead
	5	4	1 in center	Fair number, all dead
119	2	3	1 in center	Numerous, all dead
	3	5	1 in center	Numerous, all dead
120	2	3	2 in centers	Numerous, all dead
	3	2	1 in center	Numerous, all dead

[1]Examinations were made by Miss E. M. Buhrer. Code used as follows: Few = 1 to 30 specimens; fair number = 30 to 60 specimens; numerous = more than 60 specimens.
[2]Many Cephalobus alive. [3]36 Cephalobus alive.

treatments. No damage to the flowers or foliage was noticed in any of the stock treated in the autumn of 1931. After the bulbs had been harvested, cleaned, and cured according to common practice, the percentage weight increase was calculated for the two commercial Narcissus varieties, King Alfred and Glory of Sassenheim. (Table 1.)

For the King Alfred variety the check plot (untreated bulbs) shows an increase of 93.3 per cent. Four treatments did not give this increase; at 114° F. for one hour, at 118° F. for one and two hours, and at 120° F. for one hour. The weight increases after these treatments were 90.1, 92.5, 91.5, and 90.0 per cent, respectively, or an average of 2.3 per cent below that of the check. On the other hand, the other 18 treatments gave increases in weight over the check from 1.8 per cent (at 120° F. for two hours) to 41.1 per cent (at 113° F. for two hours).

For the Glory of Sassenheim variety the weight increase of the check (untreated) bulbs amounted to 98.8 per cent. Three treatments fell short of this mark, at 118° F. for two hours and at 120° F. for one and two hours. The increases were 95.2, 89.0, and 92.3 per cent, respectively, or an average of 6.6 per cent below the check. Nineteen of the treatments in this series showed an increase in weight over the check of from 6.3 per cent (at 111° F. for three hours) to 44.1 per cent (at 110° F. for five hours). The Long Island bulb growers consider a 90 per cent weight increase in their harvest of trumpet daffodils to be very satisfactory.

Although the foregoing tables do not show conclusively what temperatures and time durations are most suitable for a given variety, the indications are that tolerance to the vapor-heat treatment is much greater than that to the hot-water treatment, since no detrimental effects were evident. There is a further indication that in the treatments at the lower temperatures and for moderate time periods a decided stimulation in growth is obtained.

Effect of Vapor-Heat Treatment Upon Flowering in the Greenhouse.—In the 1931 experiments samples of 25 bulbs from each treated lot were planted in flats and later forced in a greenhouse according to commercial practice. Measurements were made of stem length, diameter of perianth, and width of trumpet. The dates of blooming, number of flowers, and the condition of the foliage were recorded.

The treated stock of King Alfred bulbs was, on the average, from one to six days later in blooming, especially after 80 per cent of the flowers had been harvested. The results for the treatments at 110° and 111° F. for three hours were found to run closely parallel to the checks and those for the treatment at 112° F. for two hours were only a little behind the checks.

The Glory of Sassenheim stock treated at the lower temperatures was a little better than the untreated checks. When the temperature of treatment was above 112° F. there was a tendency for the flowering to be delayed for two or three days. The exposure to 110° F. for five hours showed the best results, with 3-hour and 4-hour exposures at the same temperature following in the order named. Bulbs treated at 110° F. for five hours came into bloom approximately four days ahead of those treated at 111° F. for the same length of time.

No appreciable difference was noted in the size of flowers or in length of flower stems of either variety as a result of the various treatments. The foliage of both varieties was very good and especially heavy in Sassenheim after all the treatments.

SUMMARY.—The vapor-heat treatments can be satisfactorily employed for the control of the bulb flies (*Eumerus* sp.) in dormant narcissus bulbs. Even the moderate exposure at 110° F. for three hours is sufficient to control the immature forms of these pests.

There are good indications that this method of heat treatment may be successfully adapted to the control of the bulb nematode in narcissus planting stock with little, if any, injurious effect. When the 1932 season's treated bulbs have been dug and weighed, it is hoped that this point may be cleared up.

From the information derived from the 1931 treatments it is believed that the period of treatment may be lengthened without detrimental effect on field-grown stock.

At the lower temperatures the treatment results in a stimulation of growth, with a perceptible weight increase in field-grown stock. Bulbs may be successfully forced after such treatments and blooming occurs at a somewhat earlier date.

No injury to foliage by this method has been observed, even at the higher temperatures or by the longer periods of exposure.

MR. H. H. DARBY commented that applying an apparently only partially effective heat treatment to living larvae may cause sterility of the adult even when the larvae apparently survive and pupate without injury. He stated that these results were secured in experimental work carried out at the Mexico City laboratory under the direction of Dr. A. C. Baker.

DISEASES THREATENING ORNAMENTAL AND FOREST TREES

By R. KENT BEATTIE, *Principal Pathologist, Division of Forest Pathology, Bureau of Plant Industry, U. S. Department of Agriculture*

In 1922 at your Boston meeting, Dr. W. A. Orton and the writer[1] presented to the American Association of Economic Entomologists in joint session with the American Phytopathological Society, some of the biological principles underlying the plant quarantine measures which the members of your organization assist in establishing and enforcing.

At that time, among other things, we called to your attention: (1) The disturbance of biological equilibrium that occurs when a plant parasite is transferred from one plant zone to another; (2) the impossibility of predicting from the behavior of a parasite in its native home what it may do when transferred to a new environment; and (3) the necessity of studying in their native habitats parasites that are incipient in or threaten entry into our country.

THE DUTCH ELM DISEASE.—For 13 years the Dutch elm disease, known to be caused by the fungus *Graphium ulmi* Schwarz, has been spreading through Europe killing European elms, until it is now found in Scandinavia, Poland, Germany, Holland, Belgium, England, Italy, Switzerland, Austria, and Roumania. In 1930 three trees affected with this disease were found in Cleveland and one in Cincinnati, Ohio. In 1931 four additional trees were found in Cleveland. All the disease found was eradicated. No diseased trees were found in 1932, but this does not necessarily prove that the disease is not in this country. The symptoms of this disease, internal browning of the young wood and wilting of the foliage, are easily confused with those of several other elm diseases. Therefore, these diseases can not be distinguished from one another in the field but laboratory culture methods are necessary. A Dutch Elm Disease Laboratory was, therefore, established at Wooster, Ohio, in 1930 by the cooperation of the Bureau of Plant Industry and the Ohio Agricultural Experiment Station, with Mr. Curtis May of the Ohio Station in charge. At this laboratory all specimens received, whether from Ohio or elsewhere, with symptoms similar to those of the Dutch elm disease have been cultured to determine the causal organism. In 1930, 302 specimens were cultured; in 1931, 600; and in 1932, 453. In 1932 the specimens represented trees located in 19 different states. If funds permit, the station will be maintained and active watch for the Dutch elm disease will be continued.

[1]Orton, W. A., and R. Kent Beattie. The biological basis of foreign plant quarantines. Phytopathology 13: 295–306. July, 1923.

Thus far we have been unable to determine the method of introduction and of distant spread of the Dutch elm disease. The evidence indicates that it did not come into the United States on nursery stock. Solution of this problem probably must await opportunity to study the spread of this disease in Europe where already it is beyond control. Here, in its incipient stage, the disease must be eradicated.

Diseases with symptoms similar to those of the Dutch elm disease are caused by species of *Cephalosporium*, *Verticillium*, and *Sphaeropsis*.

LARCH CANKER.—In 1927 the European larch canker, caused by *Dasyscypha willkommii*, was found in a private estate, now owned by a public institution, near Hamilton, Mass., and on another estate at Ipswich, Mass. The diseased trees were destroyed at Ipswich and the whole of the infected larch planting was destroyed at Hamilton. A considerable search has been made of the northeastern United States, but to date the disease has not been found at any other point. The search is being continued.

Although this disease had been known and studied for many years in Europe, research conducted by Dr. Glenn G. Hahn, of the Division of Forest Pathology, soon developed the fact that this part of the genus *Dasyscypha* was in great confusion and it has been necessary to make careful separation of this European and certain related American species. Dr. Hahn has determined that there are two native saprophytic species which have been confused with the introduced parasite and that the introduced one is the only one which causes larch canker.

As a valuable by-product of this research, it has been determined that *Dasyscypha ellisiana*, normally saprophytic on species of pine in the eastern seaboard states and not known west of the Alleghenies, has become a parasite on Colorado Douglas fir introduced into Rhode Island. Since this is far outside of the range of this valuable tree, one can not predict the behavior of the fungus if it were carried to the West.

WOODGATE RUST.—The Woodgate rust was found in 1925 at Woodgate, N. Y., where it causes numerous galls on Scotch pines. It occurs in other Scotch pine plantings in the western Adirondacks. The organism involved is a species of Peridermium closely akin to *Peridermium harknessii*, an abundant rust in our western states. Whether or not it is identical with that species is still a subject of discussion among mycologists. No rust like it is known to occur in Europe or Asia. Inoculation experiments have shown that several of our western and southern pines are susceptible, but lack of funds has prevented the studies necessary to determine its probable behavior in the field. No new infection localities have been noted recently.

RESINOSIS OF WHITE AND RED PINE.—A canker disease attacking the crown and upper roots of the red and the white pines in an alarming fashion and characterized by copious resin exudations has been found by Dr. H. H. York,[2] of the University of Pennsylvania, in plantations at Norwich, Hemlock Lake, and Salamanca, N. Y. The causal organism has not yet been determined and the source and distribution are not yet known. The disease is known nowhere else in America or abroad, but our knowledge of root diseases of conifers is very fragmentary.

FIR NEEDLE BLIGHT.—A fir needle blight, caused by *Rehmiellopsis bohemica*, is quite widespread in Europe. The needles of the new growth become reddish and shrivel and then dark brown or black, and many cling to the twigs. The trees appear as if injured by late frosts. A needle blight found at Hamilton, Mass., in 1931 and again in 1932 proves to be this disease. It will be described by Dr. Alma M. Waterman and M. A. McKenzie, of the Division of Forest Pathology, in the January, 1933, number of Phytopathology.[3] This disease has also been found in three places at Augusta, Maine, and five places at Lake George, N. Y. All the affected trees are relatively old and have been in place for a number of years. The source of the infection has not yet been traced.

THE STUDY OF INCIPIENT DISEASES.—The diseases above mentioned seem yet to be present in the United States in very incipient form. They forcefully bring to our minds the necessity of discovering and studying such organisms when they are "rare" in our country. After a disease is fully established, its eradication is usually hopeless. It is true that in their incipient forms it is often impossible to determine certainly whether or not they present a real menace to our forests, but a few thousand dollars spent in research when a disease is new is in the nature of insurance against future catastrophe. If the investigation shows that the disease is not likely to do serious harm here, we should rejoice; if, on the contrary, it reveals a menace, early eradication measures can be undertaken.

The diseases discussed also present clearly the necessity of the study abroad of diseases incipient or likely to be introduced. It is utterly unsafe to study here the methods of distribution of the Dutch elm disease. The work should be done at once in England, across which country the disease is now marching.

[2]Anonymous. New disease on white and red pine. Journal of Forestry 30 (4): 505–506. April, 1932.

[3]Waterman, Alma M. and Malcolm, A. McKenzie. A disease of Colorado fir. Phytopathology 23:108–109. Jan. 1933.

Whether the fir needle blight is a menace to our extensive American balsam and white fir forests can best be determined by a search for information in the mountains of Europe.

Such diseases also illustrate well the complications which are met in the control or eradication of an introduced disease. The chestnut-blight organism, *Endothia parasitica*, had its saprophytic relatives and little could be done on the chestnut-blight problem until these closely related fungi could be easily distinguished.

Great complications were introduced into the work on the white pine blister rust by the discovery of a blister rust on western pinyon pine which also had a species of *Ribes* for alternate hosts, and intensive study alone solved the problem of their delimitation.

The larch canker problem is complicated by several species of *Dasyscypha* related to *D. willkommii*.

Search for the Dutch elm disease has revealed the presence of two or more other diseases with similar superficial symptoms but caused by entirely different fungi.

Our ignorance of root diseases and the unusual difficulties attending their investigation make it particularly difficult to determine whether the resinosis discovered in New York State is native or introduced.

For the solution of such problems and the discovery and eradication or control of such diseases, the pathologist, mycologist, and nursery inspector must cooperate, and it is only by means of such whole-hearted cooperation that menacing diseases can be discovered early and prevented from establishing themselves in America.

MR. BEATTIE further commented on a fungous disease found recently attacking Scotch, red, Virginia, and other pines in the eastern states. This fungus has been discovered at one point in Ohio, two places in Pennsylvania, and one locality in New Hampshire. The fungus is possibly a Scleroderris and is identical with the one described as *Atropellis pinicola* which occurs on western white pine, sugar pine, and jack pine in the Pacific Northwest, but the organism has not previously been known in the East.

The relationship between a fungus and an insect occurring on beech in Maine was also mentioned. The insect (*Cryptococcus fagi*) attacks the tree, and the fungus (*Nectria* sp.) kills the tree after the latter has been injured by the insect. Sixty per cent of the beech in the maritime provinces of Canada are infected. The insect is present around Boston but the fungus is not known to have reached that State.

THE LIMA BEAN SCAB SITUATION

By W. A. McCubbin, *Bureau of Plant Quarantine, Washington, D. C.*

Abstract

Lima bean scab, due to the fungus *Elsinoe canavaliae*, is a disease confined to this host. It is probably endemic in the Central American and West Indian regions, and is not known to occur in the United States. Being a well specialized parasite the fungus does not seriously injure its host, the outstanding damage arising from disfigurement of the pods. The evidence points to inter-season carry-over on living plants and to spread by wind. Temperature and moisture relations in Cuba indicate that it might be troublesome in at least some of our lima bean areas. Its relation to a long winter and frost are unknown and these might be limiting factors in the north. Successful control by spraying requires numerous applications involving excessive cost. The chief danger of introduction lies in the discarded pods, which may reach our fields by way of garbage. Point-of-origin inspection and certification is unsatisfactory; it both throws out too much of the crop and yet allows considerable scab infection to remain. Importation of lima beans in the shelled condition under refrigeration in transit would assure adequate protection and is regarded as a commercial possibility.

Lima bean scab due to the fungus *Elsinoe canavaliae* was first recognized as a disease distinct from Anthracnose, the common pod-spotting trouble, by Dr. Anna E. Jenkins of the Bureau of Plant Industry in 1930, from beans collected the previous year in Cuba by Dr. S. C. Bruner, and from specimens taken from Cuban bean shipments at New York by inspectors of the Bureau of Plant Quarantine. A similar disease has been described on *Canavalia*, the horse or jackbean in Ceylon, Java and the Philippines. Field evidence and experiments in Cuba by Dr. Bruner indicate that the two diseases are not identical and that the lima bean scab is strictly confined to the lima bean group.

The scab disease is also known in Puerto Rico. Interceptions of scab have also been made by our port inspectors from Mexican lima beans coming from the region around Sinaloa. Recent studies by Miss Jenkins on herbarium material from various sources has disclosed scab on lima bean specimens originating in Guatemala (1890), Costa Rica (1894), Nicaragua (1903), and San Salvador (1925). It has been in Cuba since at least 1916. It would thus appear that the disease is of long standing and is widespread over the Central American and West Indian region.

During the period March 16–20, 1931, the writer visited Cuba to make field observations there, in the hope of getting more definite information on the pest status of this scab, particularly from the quarantine point of view. From what was there learned, as well as from the studies of Miss Jenkins, and from the work of Dr. Bruner in Cuba, it is possible to present some picture of the situation which is involved in this disease.

The fungus itself appears to be of well specialized type. As noted it is not known to occur on any other host in Cuba or elsewhere. Further it seems to be so happily adapted to its host that the latter is not seriously damaged— a significant indication of specialization. This high degree of specialization in both host and habit of life suggests at once the possibility that it may also be narrowly limited in other respects.

The fungus attacks the host parts superficially, causing shallow scab areas on the pods, similar smaller scab lesions on the stems and peduncles, and typical leaf-spot effects on the leaves. Apparently it exerts little toxic action beyond the area actually attacked, so that the plant may have a considerable amount of infection without suffering from leaf-fall, yellowing, or other general symptoms of debility. With the plant's vital functions thus left intact, a pod may be covered by coalescent scab spots and still bear normal plump seeds within. There is no doubt that scab does lower the productiveness of the plant, but the most outstanding effect of the disease is the marked disfigurement of the pods by the conspicuous, red-bordered, grey-centered, blotches.

There is every evidence that the spores copiously produced by these spots are wind-borne, and that air currents play a major role in spread. A field observed by the writer in Cuba had 80–90% of its pods infected, yet no beans had grown on that land or in the neighborhood for at least several years and the nearest lima beans were at least two miles distant. The Cuban farmers also think the scab increases after every stormy period.

Moisture conditions of course favor this scab. It may be thought that the high annual rainfall in Cuba provides a condition quite different from our comparatively dry summers, so that the disease would probably not thrive here. But it must be remembered that the Cuban crop is grown in winter, during the dry season, when for the three months December, January and February the average monthly precipitation is around 2 inches, although the 10-year yearly average is 55 inches. We are also likely to misjudge the matter of temperature which during the crop period in Cuba has a mean of 74–75° F., a condition not markedly different from that prevailing in many parts of our country during the summer months.

Another feature of considerable importance in estimating the pest status of a disease is the manner of carry-over—the method by which the fungus bridges the interseason gap. The evidence in Cuba points to survival on living lima bean plants, either wild or escaped plants, those left intact by poor plowing, or old fields which have been left untouched during the summer. Such survival is understandable in a climate with but narrow seasonal variations.

Control by spraying must also be considered. From experiments conducted in Cuba by Dr. Bruner a reasonable degree of control was obtained only by means of numerous applications of spray or dust. It is questionable whether the two or three applications which our own bean industry might bear would give any adequate control of this disease.

A final interesting point in this disease, and one on which there is unfortunately no information, is its possible reaction to winter conditions above the frost line. Is it tied so definitely to its living host that it could not survive when that host perishes? Or could it, like many other fungi, pass the winter successfully on dead plant parts, debris, or in the soil? Is it capable of holding its own and surviving among the fungi of decay that rapidly invade every stricken plant? Is cold a limiting factor to the fungus itself? To these questions there are as yet no answers.

From this outline of the salient features of the disease we may pass to the inquiry as to its chances of entry into this country. It is well to note that from Puerto Rico and Cuba lima bean importation has for some years been restricted to the port of New York, and confined to the period December to March inclusive. This restriction has been established on account of the bean pod borer, *Maruca testulalis* which occurs in both islands. Entrance at New York in winter was conceded to the importers with the understanding that the imported lima beans would not be shipped south of Washington, D. C., which stipulation has not been at all times adhered to, although it is believed that southern shipments have been small and few. In Puerto Rico all beans are inspected and certified before leaving the island and in Cuba a similar service is given by the Cuban authorities, the shipments being sorted to remove scab as well as the pod borer.

In spite of these arrangements, however, Cuban beans continue to enter New York still containing a small percentage of scab, and since the fruit and vegetable quarantine relates to insects only, they have been allowed to enter there, reliance being placed on the winter season and the small chance of their moving south.

In the utilization of such beans the discarded pods of course constitute the real danger. They go out in garbage and may thus find their way to farm areas. During the year 1931 some attention was given to the garbage disposal systems of 5 Atlantic seaboard cities and three in California. In all cases except in Baltimore the methods of garbage disposal provided a channel whereby the scabbed pods might go out uncooked to trucking or farming districts. While the chances of establishment of the disease in this way may be small in some cases, there can

be no question of the reality of the danger in either eastern or western sections.

Is this lima bean scab already present in the United States? We are fortunately able to say with some degree of assurance that it does not appear to have yet established itself in our lima bean areas. This assurance is based not only on the absence of reports from the crop disease reporters of the Plant Disease Survey, but on two special surveys made during the summer of 1931. One of these, carried out in July and August by the Plant Disease Survey in cooperation with the Bureau of Plant Quarantine covered the eastern lima bean areas from New York to Florida, and during it lima beans were examined in fields, packing houses, and markets in 8 states (N. Y., N. J., Pa., Va., N. Car., S. Car., Ga., Fla.). No scab was found in any of the 100 localities visited. A similar survey was made in California in August of 1931 by the writer in cooperation with the California Department of Agriculture. In this survey 50 lima bean fields and 58 lots in the markets of 8 towns were examined in southern Clifornia without disclosing any trace of scab. Since the areas thus covered are thought to represent the territory most likely to be affected by introductions of the disease there is reasonable ground for assurance that we are still free from scab.

In view of this freedom we may venture to raise the question: What shall our future policy be in regard to this disease? Shall we aim to exclude it as an undesirable, or ignore it as something trivial?

Let us refer to the points already discussed which may be said to sum up what we know about the pest status of lima bean scab. It occurs on one host only, and that an important though not a major crop in this country. It does not cause excessive crop reduction but does disfigure the pods and thus greatly lessen their market value for sale in the pod. Successful control by spraying would promise to be expensive, but since the disease is wind-borne how could one man otherwise than by spraying protect himself against infection from a careless neighbor's field? There is hope that in the absence of inter-season living plants the disease could not maintain itself readily outside of regions where summer is virtually perpetual, but we do not know yet whether the fungus could not survive on dead plants. Similarly we are ignorant of what its behavior would be under northern winter conditions. In any case it is disturbing to note that the disease occurs in the Sinaloa region of Mexico which has climatic conditions almost identical with those of southern California. Further, the discarded pods which may carry the fungus by way of garbage channels to our fields constitute a danger that connot be ignored. Sorting out scab at the point of shipment reduces but does not

eliminate this danger. And while restriction of importation of beans from Cuba and Puerto Rico to the winter months and to the port of New York no doubt also tends to reduce this danger, no one could conclude that this arrangement provides a permanently safe procedure. In the west no such seasonal limitation exists on the bean importations from Mexico, although market and tariff considerations do discourage Mexican imports except when scarcity in California raises the price. In the west also there can be no reliance on winter conditions and the danger from garbage disposal is always present if scabby beans are on the market. In California also the points of greatest consumption of Mexican beans are in the midst of the large lima bean areas. Finally, if we add to the picture the fortunate fact that we seem to be yet free from scab, our summary of the pest status is as complete as we can at present make it.

Let us now examine the various lines of action that might be taken in the situation thus outlined.

The first that comes to mind is of course an embargo, which would effectually solve the matter by excluding all lima beans from regions where scab is known or suspected to exist. It must be pointed out, however, that it is not right or fair to use this peremptory method until all other less drastic measures are found to be inadequate.

Almost at the other extreme we find our present arrangement by which beans enter from Mexico without specific restriction, and are received from Cuba still containing after sorting appreciable percentages of scab. Continued acceptance of the risk involved in garbage disposal and shipments to the south from New York are to be considered as tantamount to eventual establishment of the disease.

If we canvass the possibilities between these two unsatisfactory extremes, it is found that because of the superficial habit of the fungus it might be biologically acceptable to treat the pods with a fungicide before they are shipped. If such a procedure could be arranged to satisfy the technical requirements of safety, and was commercially feasible, it would provide an acceptable solution. In this system the sorting out of scab need only be carried out to the point required by market considerations.

At the suggestion of the Bureau of Plant Quarantine several small experimental shipments of scabby beans were treated in 1931 in Cuba with formaldehyde under the direction of Dr. Ernesto Sanchez, Chief of the Sanidad Vegetal there, and were then shipped to New York. These shipments were examined by a representative of the Bureau of Plant Quarantine on arrival and again after they had been held in cold

storage for 4 days. While their condition in general was not entirely satisfactory there were indications that with due modifications shipment might be made successfully after such treatment. A few culture tests made by Dr. Anna E. Jenkins from specimens in these shipments indicated that the fungus had been destroyed. However, this method has such outstanding practical disadvantages that it has not been carried further than these tentative efforts.

Another proposal, equally sound biologically, involves shelling the beans at point of origin and importing only the shelled product. Practically this method has several advantages. It avoids treatment, for the danger from spores adherent to the beans is eliminated by cooking. The scabbed beans can be used since the fungus does not penetrate within the pod. All inspection at either end may be dispensed with; the method promises to be also of value for the bean pod borer problem; shelling in the country of origin could be done cheaply by local labor; and freight and container charges would be lessened.

From the protection point of view it would be possible to arrange for removal of the pods either before shipment or to allow the beans to enter under control, shelling and safe disposal of pods to be carried out under quarantine supervision. While biologically acceptable this method of handling would limit entry to a few ports, impose a load of supervision on our quarantine organization involving considerably added cost, and would necessitate some organization by importers, as well as higher labor costs in shelling. Point-of-origin shelling is the preferable alternative. The beans could then enter without restriction at any port.

However it is not yet established whether the shelled product can be shipped commercially in good condition and various features of this problem remain to be solved, such as temperature and moisture relations, aeration, type and size of container and the value of precooling.

These various points are now being investigated by Dr. L. A. Hawkins of the Bureau of Plant Quarantine. If the technical difficulties in shipping can be overcome, the method of importing lima beans in the shelled condition would seem to provide adequate safety from this disease, and at the same time avoid the necessity for an embargo on the one hand, or on the other a continuation of the present unsatisfactory situation.

THE INSECTS AND DISEASES OF RHODODENDRON AND AZALEA

By RICHARD P. WHITE,[1] *Research Specialist, Diseases of Ornamentals, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey*

It is the purpose of this paper to describe those insect pests and plant diseases of Rhododendron and Azalea which might come to the attention of the nursery inspector. It is the hope that such a tabulation as follows, will better enable the inspector to fulfill his obligations to the nursery trade in the dissemination of practical and scientifically sound information pertaining to the control of these pests. The brief symptomatic descriptions of the types of injury commonly found on these plants, with notes on the control of the insect or fungous pest, should in part, at least, fulfill the needs of the inspector. Space does not permit detailed descriptions of the organisms concerned, or their habits, except where such information is necessary to clarify the control procedures.

INSECTS

1. LACE BUG* (*Stephanitis pyrioides* Scott on *Azalea* spp. and *S. rhododendri* Horv. on *Rhododendron* spp.) (Pl. 27, A)—The azalea and rhododendron lace bugs cause similar injury on their hosts: a spotted or mottled grayish discoloration on the upper surface of the leaves with the lower disfigured by the blackish or brownish excrement, cast nymphal skins and brownish shields over the eggs which are inserted in the leaf tissue. Lace bugs are more severe on plants growing in the sun and are of little importance in shaded areas. They overwinter as eggs inserted in the leaf tissues of the evergreen types of azaleas and rhododendrons. The first brood appears in New Jersey the very last of May or during June. *Rhododendron ponticum* is not a favored host, but most other species and the hybrid varieties are very susceptible to injury. Lace bugs also occur on *Kalmia latifolia*, *Pieris japonica*, and *P. floribunda*.

Control: Contact insecticides as nicotine and soap[2] or a safe summer oil plus nicotine, particularly on azaleas where spider mites are also a

[1]Acknowledgment is made for assistance in preparing the first part of this paper to Dr. C. C. Hamilton, Associate Entomologist, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey. Journal Series paper of the New Jersey Agricultural Experiment Station, Department of Plant Pathology.

*Indicates Insect or Disease of major importance.

[2]For general nursery use sprays containing ½ per cent soap and free nicotine at dilutions of 1–2400 to 1–3000 are recommended. A safe summer oil is used at dilutions of 1–75 plus one pint of 50% free nicotine solution per 100 gallons of spray solution.

factor, every ten days during June and at wider time intervals during the remainder of the summer, directed toward the under surface of the leaves.

2. THRIPS* (*Thripidae*) On *Rhododendron* spp. and *Azaleae* spp. (Pl. 27, B)—Thrips are particularly severe on *R. ponticum* seedlings either in the greenhouse or in frames, and on *Azalea indica* and its many horticultural varieties, and *A. phoenecia* in the greenhouse. They cause a grayish-white mottling of the upper surface of the leaves, which is more diffuse or blotchy than that caused by the lace bug. On the lower surface a silvery appearance is given to the leaf with minute spots of black excrement.

Control: In frames outdoors, frequent applications of contact insecticides as nicotine and soap applied toward the under surface of the leaves. In greenhouses, particularly in grafting chambers, two applications of a contact dust insecticide.

3. SCALE (*Aspidiotus hederae* Vallot) (Pl. 27, C)—This oleander or ivy scale often occurs on leaves and twigs of older rhododendron plants, causing a yellow spotting of the foliage and if severe, a weakened growth. It is not to be considered, however, as a major pest of these plants.

Control: Spray with dormant oil sprays when the plants are completely dormant, preferably in late winter or early spring about two weeks before new growth starts.

4. MIDGE* (Undetermined)—A species of midge has caused considerable trouble in nurseries on *Rhododendron ponticum*, *R. maximum*, and hybrid varieties. It has also been found on native *R. maximum* in the Pocono mountains of Pennsylvania. These pests cause a spotting of the foliage, rolling of the leaf margins, and if numerous, a crippled, malformed, stunted terminal growth. The larvae are white, about ¼ inch long when full grown and can be found in numbers during August in the curled margins of the infested leaves.

Control: Frequent applications of a contact insecticidal spray (nicotine-soap) have afforded practical control, under field conditions.

5. CRANBERRY ROOT WORM (*Rhabdopterus picipes* Oliv.) on *Rhododendrons* pp. (Pl. 27, E)—This pest causes very characteristic feeding injury on the younger foliage of rhododendrons, typically eating out holes in the shape of a crescent or with a sharp angle. They are night feeders, spending the day in the mulch at the base of the plants.

Control: Keep foliage covered with arsenate of lead from about June 15 to August 1.

6. ASIATIC BEETLES* on *Rhododendron* spp. and *Azalea* spp.—Typical foliage injury is produced by the Japanese beetle, (*Popillia japonica*

Newm.) on the younger foliage, which results in the skeletonizing of the leaves. The injury is frequently very severe in spots in the field, due to the gregarious habits of the beetles. They may be controlled by keeping the foliage covered with arsenate of lead during the beetle flight period.

The grub of the Japanese beetle, of the Asiatic Garden Beetle (*Autoserica castanea* Arr.) and of the Asiatic beetle (*Phyllopertha orientalis* Waterh.) may cause considerable damage by feeding on the main roots and underground stems. Their activity at this point often results in girdling the roots and stems, followed by a yellowing of the foliage, wilting, and death of the plants.

Control: Apply arsenate of lead to soil at rate of 1500 pounds per acre, worked into the upper four inches,

7. Spider Mites* (*Tetranychus telarius* L.) on *Azalea* spp.—Spider mites do not appear commonly on rhododendrons under field conditions. They may become a pest on these plants under greenhouse conditions on *R. ponticum* and hybrid varieties while in the grafting chambers. On Azalea spp. however, particularly certain varieties of *A. indica*, they may occur in abundance under field conditions, and are always a menace on these varieties when being forced for Christmas or Easter.

Control: A safe summer oil diluted 1–75 to which is added one pint of a 50% free nicotine solution to every 100 gallons of spray, and applied frequently to the lower surfaces of the leaves with at least 200 pounds pressure, has given good control under both greenhouse and field conditions. Frequent applications are absolutely necessary during the summer on such favored hosts as the variety Madame Petrick.

8. Clear Wing (*Sesia rhododendri* Beut.) on *Rhododendron* spp. (Pl. 27, G.)—The adult moth appears in June and deposits its eggs in the bark. The larvae are about half grown in late August and reach full size late in October. They then appear as white grubs, with a brown head, about ½ to ¾ inch long. The injury they produce is usually apparent in September and early October, as a wilting, yellowing and death of stems and branches. The larvae burrow in wood just beneath the bark, pushing out borings as fine sawdust, usually a foot or more above ground but frequently at the soil level.

Control: Prune out and burn dead or infested branches in the fall or winter.

9. Stem Borer (*Oberea myops* Hald.) on *Rhododendron* spp. and *Azalea* spp. (Pl. 27, F.)—Causes death of branches or entire plants of Rhododendron and Azalea spp. The adult beetles emerge in June and are present during June and July. The young larvae hatching from eggs deposited at the tips of the branches, bore down from the branch tips

in the center of the stem for about 12 to 15 inches, where they pass their first winter. The following summer they continue down the stem, pushing out borings through numerous holes as coarse sawdust. The full grown larvae are yellowish, about 1 inch long, and in the fall of the second year can be found near the base or crown of infested plants. Before passing down to the base of the stem underground, or to the crown of collected plants, the main stem or branch is almost girdled about 4 to 6 inches above the soil level. Infested plants die during the autumn due to this girdling and are easily blown over by fall winds.

Control: Destroy all parts of infested plants in the autumn by pulling and burning.

10. Weevils* (*Brachyrhinus sulcatus* (Fab.) L.) On *Rhododendron* spp.) (Pl. 27, D.)—These weevils occur frequently on species and varieties of rhododendron, eating out small holes on the edges of leaves and less frequently in the center. If numerous they often destroy the entire leaf except the midrib which is not touched. They are nocturnal feeders and in the day can be found under the mulch at the base of the plant. The larvae feed on the roots during the autumn and spring. The adults emerge from about the middle of June to the last of July and feed on the foliage the remainder of the season and late into the fall. Two other species of Brachyhinus have been reported on rhododendron, but it is felt that *B. sulcatus* is the species doing most if not all the damage in this country.

Control: Lead the soil as for the control of the Asiatic garden beetle, and if necessary dust the plants with calcium arsenate-hydrated lime dust, or use poisoned bran or apple baits, such as "Go-West."

11. Leaf Skeletonizer (*Gracilaria azaleella* Brants) On *Azalea* spp. —Eggs are laid by the adult moth on the under surface of leaves close to the midrib. The larvae turn under the tip of the leaf or the margin

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Plate 27

A. Lace bug injury on *R. maximum.*
B. Thrips injury on *R. ponticum.*
C. Ivy scale on *Rh. catawbiense* hybrid.
D. Weevil injury on *R. catawbiense* hybrid.
E. Cranberry root worm injury on *R. catawbiense* hybrid.
F. Stem borer on *R. catawbiense* hybrid.
G. Clear wing on *R. maximum.*
H. *Cercospora rhododendri* on *R. ponticum.*
I. *Cercospora rhododendri* on *R. catawbiense* hybrid.
J. *Pestalotia macroticha* on *R. maximum.*
K. Leaf infections of *Phytophthora cactorum* on *R. catawbiense* hybrid.

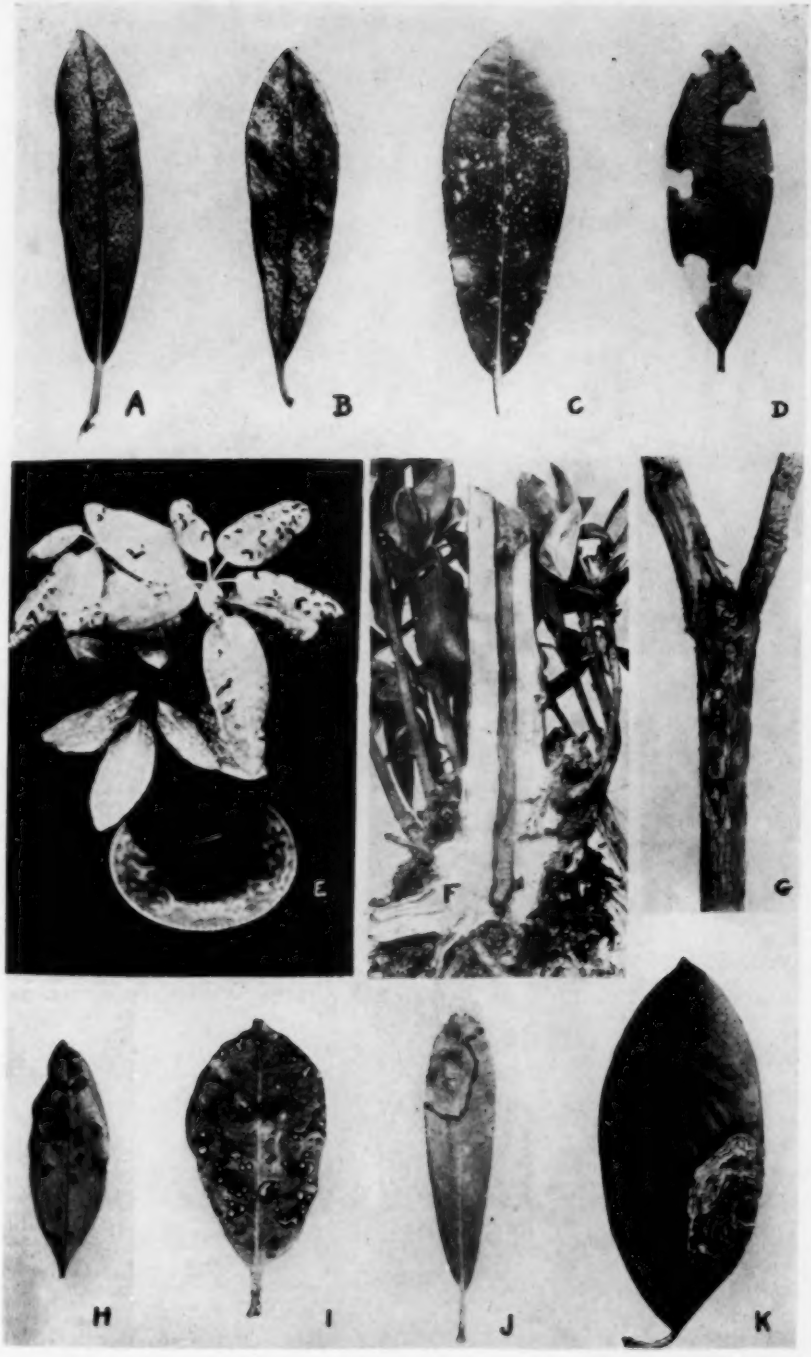
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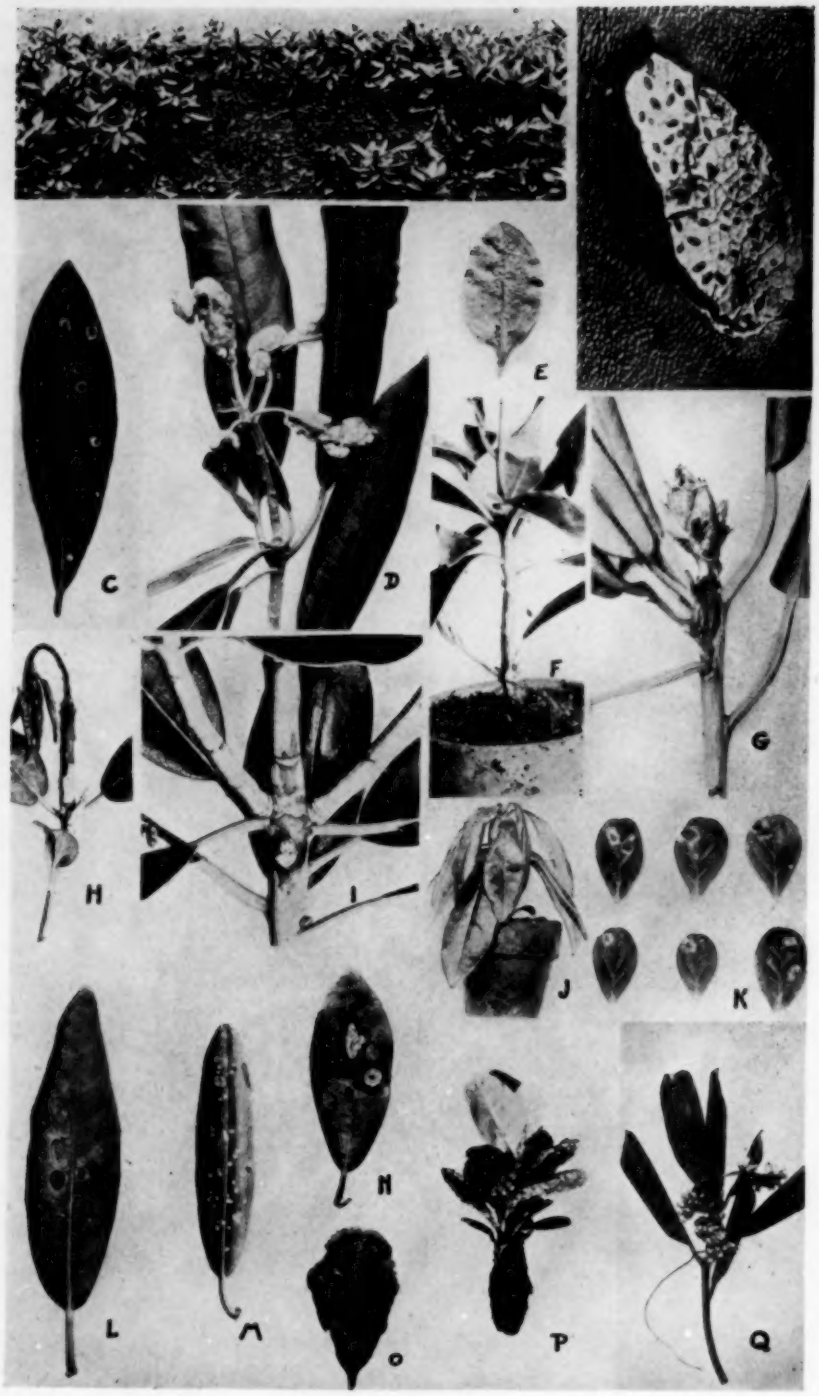
Plate 28



and fasten it down, feeding on the protected portion of the lower epidermis. This causes the leaf to wither and die.

Control: Hand pick in greenhouses if not numerous. If numerous fumigate with cyanide. In the field, if severe infestations are encountered, spray with arsenate of lead.

12. Two other insect pests have been noted on rhododendrons but are of minor importance. Felt found the Ambrosia beetle, *Corthylus punctatissimus*, working in stems of rhododendron in New York City and this pest has once been observed in nursery grown plants. The azalea scale (*Eriococcus azaleae* Comst.) occurring on the bark of rhododendrons and azaleas is also of minor importance.

Diseases

Of Leaves

13. Cercospora Leaf Spot* (*Cercospora rhododendri* Mar. and Verpl.) (Pl. 27, H, I.)—This disease is characterized by the formation of angular dark brown spots on leaves of *R. ponticum*, with a grayish down or pubescence in the center of the spots on the upper surface due to the sporulation of the organism. On certain hybrid varieties, these spots are similar, although the center of the spot may become silvery white, due to the lifting of the epidermis. Most severe on lower foliage of young stock.

Control: Bordeaux mixture, 2–2–50 at 10 to 14 day intervals during the growing season.

14. Rust (*Pucciniastrum minima* Arth.) on *R. ponticum*. (Pl. 28, E.)—On young seedlings, this rust appears as a red spotting of the foliage,

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Plate 28

A. Bed of *R. ponticum* showing wilt infection.
B. Lophoderium leaf spot on *R. maximum*.
C. Yellow leaf spot on *R. ponticum*.
D. Gall on leaves of *R. maximum*.
E. Rust on young seedling leaf of *R. ponticum*.
F. Basal canker caused by Rhizoctonia on *R. ponticum*.
G. Bud blast on *R. maximum*.
H. & I. Phytophthora blight on *R. catawbiense* hybrid.
J. Wilt infected plant of *R. ponticum*.
K. Leaf scorch of *Azalea hinodegiri*, young infections.
L. *Phyllosticta saccardoi* on *R. maximum*.
M. *Phyllosticta* sp. on *R. maximum*.
N. *Phomopsis* sp. on *R. catawbiense* hybrid.
O. Mosaic on *R. catawbiense* hybrid.
P. Slime mould on *Azalea schlippenbachii*.
Q. Dodder on *R. carolineanum*.

uredosori becoming abundant on the lower surface of the leaves as orange-red pustules. Heavily infected seedlings, if small, may be killed completely, and usually the lower leaves wither and die. Rust infections are often followed by *Pestalotia macrotricha* Kleb. so as to give one the impression that the rust had caused a widespread necrosis. Disease of minor importance usually.

Control: Use dusting sulfur at two-week intervals during July and August if necessary, particularly on seedling stock plants.

15. Western Rust (*Melampsoropsis piperiana* Arth.) On *R. californicum*.—This rust disease occurs in great abundance on native *Rhododendron californicum* on the western coast, but has not been observed on other species. Numerous small, reddish yellow spore pustules are produced on the lower surface of infected leaves.

Control: Although no work has been done on the control of this rust, the use of dusting sulfurs as above should prove efficacious.

16. Yellow Leaf Spot (*Exobasidium vaccinii* (Fcl.) Wor.) on *R. ponticum* and other species and hybrids. (Pl. 28, C.)—On the former species, where it is most severe, very distinct yellow spots are produced on the foliage, at first minute and circular, later enlarging with irregular or scalloped margins and brown centers. Frequently the margins become tinged with red. Sporulation occurs as a fine white meal on the lower surface of these spots. On other species and hybrids in general, a brown necrotic spot occurs without the primary yellow spotting.

Control: Bordeaux mixture 2–2–50 at 10–14 day intervals on *R. ponticum* where control is most needed.

17. Gall (*Exobasidium oxycocci* Rost.) (Pl. 28, D.)—This gall forming species of Exobasidium occurs commonly on *R. maximum* and *R. catawbiense* in their native mountain habitats and on *Azalea* spp. under greenhouse conditions. Typical large white galls are formed on young foliage, sometimes on the petals of opening blooms and seed pods. Galls may involve the entire leaf or inflorescence.

Control: Hand picking young galls in greenhouses. Spraying with 2–2–50 Bordeaux mixture at 10–14 day intervals will also assist in checking infection.

18. Phyllosticta Leaf Spots (*Phyllosticta* spp.) On *Rhododendron* spp. (Pl. 28, L. M.)—There are at least three distinct species of Phyllosticta causing leaf spots on Rhododendron. *Phyllosticta saccardoi* Thum and *P. maxima* E. & E. cause symptoms much alike. Both species cause spots either marginal or terminal on the foliage. The dark brown zonate, necrotic spots often cover half of the leaf. The upper surface is slightly roughened to the touch due to the slightly protruding

beaks of the pycnidia. These pycnidia are usually very abundant in the former species and sparse in the latter. The third species causes a silvery white spot on the foliage of *R. maximum*. The spots are light brown on the under surface of the leaf, are not over 3/8 inch in diameter, and minute black pycnidia occur sparingly in the center of the spot on the upper surface of the leaf. The former two species are of general occurrence and together do considerable damage. The last species is of little economic importance.

Control: Since these spots usually occur only on larger plants of salable sizes in the nursery, fungicides are not usually recommended. If of sufficient severity to warrant fungicidal applications, two applications of Bordeaux mixture, 10–14 days apart immediately after blooming should be recommended.

19. Lophodermium Leaf Spot (*Lophodermium rhododendri* Schw.) On *R. maximum* and *R. californicum*. (Pl. 28, B)—This disease causes large silvery white spots with reddish raised margin on the foliage of *Rhododendron maximum* particularly in the southern states and on *R. californicum* on the western coast. Very prominent oval black fruiting bodies appear on the upper surface. The lower surface of infected areas is a light chocolate brown.

This disease is of little economic importance in nurseries.

20. Azalea Leaf Scorch* (*Septoria azaleae* Vogl.) On *Azalea hinodegiri*, *A. indica* and its varieties, *A. albicans* and Ghent azaleas. (Pl. 28, K.)—Rather diffuse yellowish areas first appear on foliage, becoming brown in the center as they enlarge, and more definite in outline. Bright or deep reddish margins to the spots are common on some varieties, absent on others. On Madame Petrick and other indica varieties, primary yellowish spots do not always occur, the tissues immediately becoming brown surrounded by a deep reddish border. The leaves fall prematurely thus interfering with the forcing of the plants. Sporulation is abundant on the fallen foliage in pycnidia on either surface of the leaf, but very rare on foliage still on the plants. Very minute pycnidia, occuring in groups can be seen with difficulty without the aid of a lens. *A. hinodegiri* is the most susceptible species, but Madame Petrick variety (indica) is also very susceptible. The disease is most severe under greenhouse conditions, on forcing varieties during the fall and winter.

Control: Bordeaux mixture applied at 10–14 day intervals during the growing season from July 15 until plants are housed.

21. Mosaic (Virus) (Pl. 28, O.)—Malformation in the shape of leaves of *R. ponticum* and certain hybrid varieties, accompanied by marked

wrinkling or rugosity of the leaves and chlorotic areas, has frequently been observed in nurseries, and has been reported as mosaic from Germany. Attempts to transfer the condition to healthy plants by inarching has failed, and the true nature of this disturbance is still in doubt.

Leaf and Stem Troubles

22. PESTALOTIA LEAF AND STEM SPOTS. (*Pestalotia macrotricha* Kleb. and *P. rhododendri* Guba). (Pl. 27, J.)—Both these organisms are weak parasites, gaining entrance to the plant through weakened or injured tissues. The spots on the foliage are silvery-gray on the upper surface, light brown below, and thickly dotted on the upper surface with the black acervuli and spores of the organisms. During wet weather the spores may ooze out in tendrils or as black droplets. On stems, the same silvery spots are produced. The former species is the most common fungus found associated with necroses on rhododendron, and follows such injuries as insect feeding or sucking punctures, sunscald, winter injury, and lesions produced by other fungi. *P. macrotricha* also occurs on *Azalea* spp.

Control: Prevent winter injury by mulches and wind breaks such as coniferous evergreens or artificial frames. Control insects, and provide generous mulches.

23. PHOMOPSIS LEAF SPOT AND CANKER (*Phomopsis* sp.) (Pl. 28, N.) On the foliage of certain hybrid varieties and *Rhododendron maximum*, rather large spots, 10–15 mm. diameter, with a broad definite, reddish brown border, are produced by this organism. These spots are silvery white in the center, zonate, and with numerous pycnidia of the organism concentrically arranged in the center of the spot on the upper surface. This fungus also causes indefinite cankers on older stems, resulting in the death of the infected branches.

Control: Cut out and burn infected branches.

24. PHYTOPHTHORA BLIGHT* (*Phytophthora cactorum* (Leb. & Cohn) Schroet.) (Pl. 27, K., Pl. 28, H.I.)

This widespread fungus found on many hosts causes large water soaked areas on the foliage of hybrid varieties of rhododendron, under conditions of dense shade and high humidities. The infected areas become brown, zonate, silvery white in spots on the upper surface, and light chocolate brown below. On tender new growth dark brown sunken cankers and a general die-back of the branches are produced. Girdling cankers are formed on older tissues killing all the terminal portions of the infected branch. The fungus advances down the stem, often killing the entire plant.

Control: Lessen shade if possible. Prune out all diseased branches and burn. After blooming spray with Bordeaux mixture 2–2–50, making at least two applications 10–14 days apart.

25. Botrytis Blight (*Botrytis* sp.)—Botrytis blight is severe only on seedlings or on plants in the grafting chambers. Infected leaves and stems are usually covered with a grayish brown felt composed of spores and conidiophores of the fungus. In grafting chambers, leaves and young stems are rapidly decayed. In seedling frames, sclerotia are produced in the infected leaf tissue. The fungus overwinters as sclerotia in leaf fragments.

Control: Rotate frames for growing seedling stock. Bordeaux sprays have been effective in frames if applied at 7–10 day intervals during cloudy or wet weather. Copper-lime dust should prove satisfactory in grafting chambers.

Bud Diseases

26 Bud Blast (*Sporocybe azaleae* (Pk.) Sacc.) On *Azalea* spp. and *Rhododendron* spp. (Pl. 28, G.)—This disease is particularly severe on *R. maximum* in its native habitat in the southern mountain regions. It causes a browning and death of the buds and frequently a slight canker at the base of the bud. The infected buds are covered with minute black bristles, the sporulating tufts of the organism. It has been observed but once in commercial nurseries and is, therefore, of little economic importance except on collected stock from regions where it is known to occur.

Root and Stem Diseases

27. Wilt* (*Phytophthora cinnamomi* Rands) On *Rhododendron* spp. (Pl. 28, A. J.)—Wilt is particularly severe on *R. ponticum* and hybrid seedlings. This disease is primarily one of young stock. It occurs frequently on grafted plants, however, two and three years old, but is rare on older plants. It causes a root rot, wilt, and death of seedlings in frames in spots usually. The organism is soil harbored.

Control: Practice rotation of frames for growing stock, adjust soil acidities to pH 4 to 4.5, use light soils with good drainage, and avoid excess of irrigation.

28. Damping-off and Basal Canker (*Rhizoctonia solani* Kuhn.) (Pl. 28, F.)—The most frequent cause of damping-off of rhododendron seedlings is the common Rhizoctonia. It also causes a canker at the union of scion and stock in grafting chambers, and a basal canker at the soil level on one and two year old *R. ponticum* plants. Such cankers cause

plants to turn yellow, wilt and eventually rot off completely. It also causes the death of branches of older plants of *R. carolineanum* and probably of other species.

Control: Light mist sprays of organic mercuries on seedling flats have given control of damping-off but such sprays should not be applied until after the hypocotyls are free from the seed coat and standing erect.

29. Root Rot (*Armillaria mellea* (Vahl.) Sacc.) On *Rhododendron* spp. and *Azalea* spp.

Plants are killed by the attacks of this fungus on the roots, where it causes a wet decay of the cortex and bark, which has a distinct mushroom odor. Black strands of fungous tissue envelop the roots and enter the cortex. White fans of mycelium are usually present under the loosened bark immediately above the soil level.

Control: Increase the vigor of the host by fertilization, and if plants are not too far gone, exposure of the crown to the air for a year has been advised.

30. Dodder (*Cuscuta gronovii* Willd.) On *Rhododendron* spp. and *Azalea* spp. (Pl. 28, Q.)—Dodder seeds are brought to the nurseries in muck soils and leaf molds used in preparing the nursery soils for these plants. Young dodder plants twine about their host, attaching themselves by means of haustoria. It is through these haustoria that the dodder derives all its moisture and nutrients. This parasitic flowering plant, very evident in June as long bright orange yellow runners, causes a reddening of the foliage of the attacked plant, due to the loss of nutrients. It frequently causes defoliation beyond the point of attachment.

Control: Pick out the bright orange yellow runners early in the summer and do not let the plant go to seed.

Non-Parasitic Diseases

31. Slime Mould (*Physarum cinereum* (Batsch.) Pers.) (Pl. 28, P.)—This slime mould under conditions of high humidity frequently covers the lower leaves of seedlings with a slime and later a dark purplish gray powdery spore mass. The organism is not strictly parasitic, but if abundant, it causes the death of the seedlings by suffocation. *A. schlippenbachii* seedlings have been observed completely covered with the fruiting structures of this mold and killed thereby.

THE PROTECTION OF FOREST NURSERIES FROM WHITE-PINE BLISTER-RUST INFECTION

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ABSTRACT

White pine nursery stock can be, and in many cases is being, protected from blister rust by a Ribes-free zone around the premises. Consistent intensive effort is required and the costs range from less than one hundred dollars to a thousand dollars or more for a single nursery. An annual follow-up is necessary. Only five-leafed pines so protected are allowed to be shipped out of infected States except where the shipment is consigned to a point in one of the several northeastern generally infected States.

All white pine nursery stock should be produced under protected conditions, not only to avoid the danger of introducing the blister rust into uninfected localities, but to avoid loss and disappointment on the part of the purchaser.

The gradual spread of the white pine blister rust has made the protection of white pine nursery stock from infection even more important and pressing than in past years owing to the increasing number of nurseries which are becoming exposed to infection. Nursery concerns which produce white pines or other pines which bear needles in bunches of five should by all means take steps toward the protection of the stock at the earliest possible date even though the blister rust is not as yet known in their vicinity or even in the State in which they are located. While the necessary Ribes eradication work will require some time and effort, the increased market authorized under the blister rust quarantine regulations and resulting from the known healthy condition of the trees should make the work well worth its cost for nurseries having any considerable volume of business in the production of conifers.

Quarantine regulations issued for the purpose of retarding the spread of the white pine blister rust into uninfected localities prior to 1928 primarily involved embargoes on the shipment of five-leafed pines from infected to noninfected regions or from generally to lightly infected areas. Under these embargoes no interstate movement of five-leafed pines into protected areas was allowed under any conditions.

By 1928, investigational work and large-scale field experience in the protection of forested areas against blister rust infection by Ribes eradication had reached such a stage that it seemed possible to undertake the protection of nursery plantings of five-leafed pine in a similar manner. A revision of the Federal blister rust quarantine regulations was issued during the summer of that year, effective August 15, 1928, making provision for this new plan. It authorized the interstate movement under permit of five-leafed pines from the generally infected areas, con-

sisting of the New England States and New York, into the lightly infected States east of the Great Plains regions and also from Washington into Oregon and Idaho when they had been raised from seed in a nursery free from Ribes plants and with a Ribes-free zone around the premises. The change was based on the proven effectiveness of a Ribes-free zone as a permanent protection to five-leafed pine stands.

PRESENT AND PAST REQUIREMENTS AS TO MOVEMENT.—The specifications prescribed for the protection to be given approved five-leafed pine nursery stock are given in regulation 2 of Federal quarantine No. 63. They have remained substantially unchanged since 1928 and are as follows:

> Such pines shall be grown from seed in a location within 1 mile of which there have existed since the time of planting said seed no European black-currant plants and within 1,500 feet of which there have existed since the time of planting said seed no currant or gooseberry plants of any size or variety which in the judgment of the inspector would involve risk of spread of the white-pine blister rust.

These restrictions are more stringent than are the control measures which are applied to forest lands, a 1500-foot Ribes-free zone being required around nursery premises, while a 900-foot zone is sufficient for forest protection. This difference is due to the fact that the sporidia from Ribes (other than *R. nigrum*) may be carried more than 900 feet by the wind but that they usually do not remain viable beyond that distance in sufficient numbers to cause significant damage in commercial pine stands. In the case of nursery stock, as nearly as possible an approach to absolute protection is attempted.

A revision of the blister rust quarantine regulations, effective January 1, 1933, further recognizes the practicability of protection of five-leafed pines in nurseries located in the infected States by authorizing nation wide movement in cases where the stock is found to have been grown from seed in Ribes-free areas. In this revision five additional States—Iowa, Ohio, Maryland, Virginia, and West Virginia—and the District of Columbia, are classed as infected.

The Mississippi Valley line has been eliminated as a line past which shipments of five-leafed pines may not be moved from east to west, and it will be noted that five-leafed pines may hereafter be consigned from non-infected States to any part of the country under the State Nursery Inspection Certificate issued by the State from which the shipment is shipped.

Another important change in the present regulations is that the destinations to which pines are allowed to move under Federal permit

may be limited. The extent of such limitation will depend primarily on the status of the nursery involved with respect to known infestation of blister rust in that part of the country and the local condition in and around the nursery with respect to freedom from Ribes.

A Ribes-free zone greater than 1500 feet in width may be required when necessary in the department's judgment to ensure freedom from infection. This additional safeguard is expected to be required in cases where there are concentrations of Ribes very close to the 1500-foot boundary, or where there are mountains, ledges or exposed areas on which Ribes are growing near such boundary.

Experience in the administration of this work and in the inspection of the environs of the nurseries during the past 3½ years has resulted in the development of a considerable body of information concerning the practicability and effectiveness of nursery protection by this means.

PROCEDURE.—The present plan of procedure is that upon receipt of an application from a nursery, the application is referred to the Bureau of Plant Industry for any information they may have concerning Ribes conditions in the environs of the nursery or the extent to which Ribes eradication may have been carried out in the vicinity in connection with the general prosecution of cooperative blister rust control work. This work is conducted jointly by the Bureau of Plant Industry and the affected States. In a number of cases this request results in information coming from the Bureau which shows definitely that the Ribes have not been eradicated in the vicinity of the nursery. In such cases no inspection by the Bureau of Plant Quarantine is made at that time but the nurseryman is advised to consult with the Bureau of Plant Industry and with the State nursery inspector as to the methods and cost of Ribes eradication and the possibility of making arrangements for securing trained supervision and assistance in the work in cooperation with Federal and State authorities.

After careful Ribes eradication has been carried out in the vicinity of the nursery, freedom from Ribes is checked by a competent, experienced quarantine inspector and a general study and report of the situation are made. If the nursery and its surroundings are found to be disease-free and Ribes-free to the extent required by the regulations, permit for the interstate shipment of five-leafed pines either to lightly infected States, to all States except the Pacific Southwest, or throughout the United States is issued. If a careful job of Ribes eradication has been accomplished and no sprouts or seedlings are found except a limited number which can be and are pulled up in the early spring before sporidia can be distributed, a permit is likewise issued to the owner.

In a considerable number of instances, however, inspectors have reported that, in spite of rigorous efforts at Ribes eradication, Ribes plants are proving so persistent that no permit can be issued for the season concerned. These cases may be divided into two classes. In one class the nurseries are located in such a situation, e. g., near swamps, that there appears to be no probability that a complete and satisfactory job of Ribes eradication can be accomplished within a reasonable number of years. This condition has been due in some cases to beds of skunk currant with very persistent root stocks which experience has shown are difficult to eliminate. In other cases, particularly in the Pacific Northwest, certain native species of Ribes plants grow under stream-type conditions which are difficult to control to the extent necessary for nursery protection.

The second class of nurseries to which it has been necessary to refuse permits is that in which Ribes eradication efforts will need to be extended through one or more additional seasons before the work can be completed. In one instance this was due to Ribes sprouts and seedlings coming up under a dense mat of Potentilla where it would be necessary to eliminate the Potentilla before Ribes eradication could be completed. In another instance this was due to the presence of such heavy stands of poison oak among the Ribes as to decrease crew efficiency through the workers' knowledge of the virulence of the poison oak. In another case a deep swamp with standing water showed Ribes growing on small low islands.

One of the features of the plan of operation has consisted in requiring that application be filed with this Bureau before the pine seeds were planted. This requirement is made in an attempt to avoid disappointment on the part of nurserymen who might plant seed with the expectation of having a market outside the infected regions and then find that Ribes eradication in the vicinity was too expensive or diffiicult to be practicable. The Department after finding that Ribes eradication has been carried out satisfactorily around a plot on which the nurseryman expects to plant pine seeds, tentatively approves the plot subject to reinspection before the resulting pine seedlings are shipped.

Even after tentative permit has been issued and the pines are growing on the premises, the persistence of sprouts and seedlings in the vicinity has involved something of a problem. In one case it has in fact been necessary to refuse a permit on this basis after one had been issued during the previous year for the same tract. It is necessary for the nursery to arrange for crew coverage of the environs of the premises each spring to be sure of the elimination of sprouts and seedlings before there is any possibility of the development and distribution of sporidia.

COSTS.—With regard to costs, it will be recalled that the average cost of commercial protection of forest stands ranges from 20c or less per acre to several dollars per acre in the eastern States and may run into considerable sums in stream-type eradication in the Rocky Mountains and Pacific Coast areas. In protecting *forest* stands, active crew eradication effort may be necessary over a much smaller area than is covered by the pine itself and satisfactory control is accomplished by keeping the Ribes factor below 50 or 100 feet of live stem per acre. In the protection of a *nursery*, however, it is necessary not only to cover the area on which the pine stock is raised but also the 1500-foot border and to do the work very intensively so as practically to eliminate all live stem entirely. This greatly multiplies the acreage to be covered and the cost. A 1500-foot border around a 25-acre plot occupies over 300 acres in addition to the area of the plot itself. The exact acreage depends on the shape of the plot. In the case of nurseries growing five-leafed pines strictly for reforestation purposes, the 25-acre plot used as an illustration may be large enough to provide for crop rotation and other nursery management practices. If the pines are being grown by wholesale nurseries on a considerable scale, some of their output will probably be intended for ornamental use and it is then necessary for the nursery to provide space not only for its seedling plantings but also to spread the young trees out over a very much larger area than the seedling plot, after they are two or three years old. In such cases, a total protected area of 25 acres may not be sufficient and each acre added to the protected plot makes it necessary for the Ribes eradication crew to cover 3 or 4 additional acres in the environs.

Under ordinary conditions a nurseryman needs to undertake Ribes eradication therefore with the definite expectation of spending several hundred dollars to accomplish it and this amount may run into $1,000 or more in the event that any particularly difficult situation—such as swamps, streams, or rocky cliffs are involved. Casual attempts to eliminate Ribes without consistent and supervised crew work have invariably resulted in disappointment.

EXPERIENCE SINCE 1928.—During the fiscal year 1929, applications were received from nine New York and New England nurseries for certification under these provisions. In five instances wild or cultivated currant and gooseberry plants were found within 1500 feet of the nursery premises and it was necessary to withhold certification of the premises concerned. In an additional pine-growing nursery, blister rust was found on the premises, and in still another instance, while no Ribes were found within the 1500-foot zone, there was evidence of such Ribes having

been present in the past since the pine seed had been planted. Certification was necessarily also refused in both the latter two cases. The two remaining nurseries from which applications were received were issued permits during the summer of 1929, one in Maine and one in Vermont.

In the spring of 1930, a third permit was issued under these provisions, this one to a nursery in New York. In addition, a tract in Connecticut on which a nursery has since planted five-leafed pines was tentatively approved for that purpose.

During the spring of 1931 applications were received from seven nurseries in the New England States and one in New York, and inspections of their premises were made in May and June. The premises of five out of the eight were found to be maintained in compliance with the requirements although only four permits were issued, as one of the nurseries had transplanted pines in such a way that they had been exposed to infection. Three of the four permits covered plots in which the pine was still too young for sale.

In the meantime, four nurseries in the Pacific Northwest have engaged in similar Ribes eradication. Two of them have discontinued their efforts, apparently because of difficulties involved in establishing a Ribes-free protective zone. Of the remaining two nurseries, one, in Montana has not yet submitted an application for a pine-shipping permit. The other, located in Idaho, has been issued a permit authorizing shipment into the infected States.

During recent months permits have been or are being issued, in the eastern United States, to one nursery in New York, two in Iowa, one in West Virginia, and two in Maryland. The permits to the nurseries in Iowa, West Virginia and Maryland are issued under the authorization given in the last sentence of paragraph 4 (a) of Section B, Regulation 2 of the white pine blister rust quarantine, as revised effective January 1, 1933, which reads as follows: "The requirement that the Ribes-free conditions described must have been maintained since the time of planting the seed may be waived pending the completion of Ribes eradication in the environs of the nursery, in the case of premises which, on account of their great distances from known points of blister-rust infection and the relative scarcity of susceptible Ribes in the vicinity of the five-leafed pine stock, represent in the judgment of the Bureau of Plant Quarantine little or no risk of being involved in blister rust infection".

None of these permits now outstanding, however, authorize distribution throughout the entire United States. All of them specify the States into which shipments may be made, in some cases limiting distribution to the infected States, and in others authorizing shipment throughout

the United States except into the southwestern limber pine and sugar pine area.

RESULTS.—Thus far no blister rust has been found on any five-leafed pine nursery stock grown under the protected conditions specified in the quarantine regulations. The results from that standpoint are most gratifying. It is necessary to interpret this fact in connection with the unsatisfactory record of nurseries located in generally infected areas where Ribes eradication has not been carried out satisfactorily in the vicinity. These nurseries are in many cases examined by the State nursery inspectors, and State nursery inspection certificates have been issued. In several instances the inspectors (or the nurserymen) have culled out visibly infected pines and the rest have been certified as apparently free from disease. In view of the fact that the blister rust cannot normally be seen on the infected pine until from twelve months to several years after the infection takes place, this practice has resulted in the shipment and transplanting of infected trees. In one instance of this kind in which an interstate shipment resulted in the planting of white pine at a considerable number of locations after redistribution in the State of destination, it was discovered two years later that many of the trees were infected with blister rust, and this case has resulted in protests against the shipment of five-leafed pines which have not been given adequate blister rust protection.

SUMMARY AND COMMENTS.—Experience since 1928 indicates that the protection of five-leafed pines in nurseries located in blister rust infected areas is practicable.

The method consists in the elimination of all Ribes for 1500 feet or more around the nursery and the destruction of *Ribes nigrum* for a distance of one mile.

The area which must be covered in the 1500-foot zone varies from 300 acres upward depending on the size of the nursery plots.

The one-mile zone from which *Ribes nigrum* must be eliminated occupies an area of approximately 3½ square miles.

The cost of the protection of a nursery can be expected to vary from less than one hundred dollars to one thousand or more depending on the nature of the nursery's environs.

Persistent eradication work repeated for a number of years has proven to be necessary.

The department has not refused permits where the only Ribes found were a limited number of sprouts and seedlings discovered and destroyed in the early spring. Nevertheless less than one-half of the New England and New York nurseries which have engaged in Ribes eradication work

around their premises, have as yet been able to reach the standard needed for protection.

Five-leafed pines grown in nurseries in generally infected areas without satisfactory rust protection by means of Ribes eradication, are likely to and, in many cases, do carry at least a small percentage of infection. Roguing of visibly diseased trees does not constitute protection against such carriage of infection by the nursery stock concerned.

A very small degree of infection, such as less than 1%, is, in an economic sense, probably unimportant in the case of commercial plantings of pines located in territory generally infected with the blister rust. Pines planted in such an area, regardless of source or freedom from disease when planted, should be permanently protected against blister rust infection by Ribes eradication or they are likely not to reach maturity.

Five-leafed pines grown in infected sections of the United States should not be planted in noninfected areas (especially in States in which five-leafed pine stands are of commercial importance) unless the nursery stock has been grown from seed under the standard rust-protection conditions outlined.

Is the Absorption of Copper by Certain Crop Plants Influenced by Climatic, Soil, or Other Factors? In connection with the use of Bordeaux mixture (4–4–50) as a spray for the control of *Empoasca fabae* (Harris) on peanuts, it was desired to learn whether this host plant absorbed copper through the foliage (thereby killing the leafhoppers as an insecticide) as DeLong, Reid, and Darley reported for beans and potatoes in Ohio. (See Jour. Econ. Ent. 23: 383–394.) The first tests were made at Arlington Experiment Farm (P. O., Rosslyn, Va.) September 6, 1932, on the juices extracted from 100 grams of green leaves of sprayed and unsprayed peanuts. The hydrogen sulphide and potassium ferrocyanide tests were both used and three series of these tests for copper gave only negative results. Further sprayings with Bordeaux mixture were then made September 15 on peanuts, potatoes, and beans, which crops were all in a good growing condition. A total of nine series of tests on the sprayed and the unsprayed plant material yielded only negative results. The xanthate method, applied qualitatively (see Jour. Ind. Eng. Chem. Anal. Ed. 3:314, 1931), was next used on each of two ashed samples (50 grams green weight) of both peanuts and potatoes, sprayed and unsprayed. No significant differences in the amount of copper in the four samples from each kind of plant were found. The results of these preliminary tests are presented to direct attention to the fact that, under certain conditions of climate and soil, copper from Bordeaux mixture may not be absorbed by the plant.

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STATUS OF POTATO WART IN 1932

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ABSTRACT

Potato wart was introduced into the United States presumably from Europe about 1912 but was not discovered until 1918. To date infection has been found in three states, Pennsylvania, Maryland and West Virginia. Introduction seems to have resulted from potatoes imported and distributed through company stores to various mining districts where many gardens but few farms are known to harbor the disease. Control has been through enforcement of a quarantine which permits planting of immune varieties only and prohibits movement of potatoes and various other carriers out of the restricted areas. Very few additional infections have been found since the original survey, indicating that the quarantine has been effective. Investigations by the Pennsylvania Department of Agriculture have revealed that: (1) Infection persists in the soil after a lapse of thirteen years in potato growing; (2) Thorough cultivation for six years tends to reduce but has not eliminated wart; (3) Very little, if any, wart develops above seventy degrees F. soil temperature; and (4) Certain new soil sterilizing materials look promising for use in connection with administration of the wart quarantine.

It has not been definitely established just when or exactly how potato wart was introduced into this country but it is apparent that it must have occurred several years prior to its discovery near Hazleton, Pennsylvania, in 1918; that is, either before or soon after establishment of foreign restrictions provided for in the Federal Act of 1912. All indications point strongly to the rather heavy importations of potatoes during the short crop year of 1912. At least it is true that considerable quantities of potatoes were imported at that time from infected areas of Europe and distributed through company stores in various sections where wart was later discovered.

Fortunately a large majority of areas affected are distinctly isolated, both physically and as to the normal movement of the potato crop. At least this continues to be the case in Pennsylvania which contains the bulk of the territory affected. The fact that there is practically no outward movement of commodities likely to carry wart greatly favors the maintenance and effectiveness of restrictive measures, and eases the burden on those who must comply with local restrictions.

Another fortunate feature is that the original survey conducted by the federal department and states cooperating functioned practically one hundred per cent in locating infected areas. Where the natural handicaps are taken into account, as well as the fact that only the status of areas planted to susceptible varieties at that time could be determined, it is nothing short of remarkable that the determination of the extent of infection could be made so complete.

The main feature of wart control work in Pennsylvania, and I believe in Maryland and West Virginia as well, has been the maintenance of a quarantine. At the beginning there was some support for complete prohibition of potato culture in the restricted areas but finally the use of immune varieties was adopted as a policy throughout the general area with outward movement of the crop prohibited. Within the past two years Pennsylvania has permitted planting of any variety in certain locally isolated areas within our main quarantine district in which wart had not been found. Such plantings, however, are made under special permit and receive special inspection, both during the growing season and at digging time, and potatoes so grown may not be moved out of the restricted area. So far wart has not been found in these special areas notwithstanding they were exposed to infection from nearby areas from 1918 to 1930. Here again the situation is likely favored by the fact that we are dealing with isolated mining communities where potatoes are grown in small patches and gardens and there is practically no surplus for market or even sale to neighbors.

This growing of susceptibles under control in sections likely to have been originally infected, or through exposure to have since become infected, should contribute to our knowledge of the natural dispersal of wart when unrestricted. In fact, had such a policy been adopted at the beginning, we should have known very definitely by this time the exact extent and location of infection throughout the regulated areas. Such information would be very valuable if the time ever comes when we can proceed with a program of soil treatment or other means of cleaning up infected districts. Consequently, in the case of a small additional infection recently discovered in Pennsylvania, it is planned to require the use of immunes only in the two or three gardens known to harbor disease. Other varieties may be planted elsewhere within the area but only under permit, with field and digging inspection and outward movement prohibited. In this way we hope to locate all infections within the area and if investigations under way prove it practicable, to clean them up as found.

It is perhaps true that among plant quarantines now or formerly in effect, the potato wart quarantine stands out as one of the most effective in preventing the spread of the pest concerned. Notwithstanding Pennsylvania has done extensive scouting outside the quarantine districts during the past thirteen years, giving special attention to suspected areas, only four small spots have been found in addition to those located by the original survey. Three of these were near infected territory and all show unmistakable evidence of dating back to the original infection.

INVESTIGATIONAL WORK.—Ever since the discovery of potato wart in Pennsylvania, attention has been given by both state and federal agencies to a study of the technical aspects of the wart situation as a necessary adjunct to proper quarantine procedure. A well equipped laboratory, provided by the Pennsylvania Department of Agriculture, is located at Hazelton and field plots with additional laboratory facilities are in operation near by. A series of automatically controlled temperature tanks constitute an interesting and essential part of this equipment. Mr. R. E. Hartman, who has been identified with the wart work in Pennsylvania since the beginning, is in charge of these investigations as well as the field administration of the quarantine.

The present program includes, among other things, studies of the longevity of wart in the soil; effect of soil temperatures and moisture; effect of various cultural practices; additional host plants and trial of various chemicals as soil sterilizing agents. Most of these, or perhaps all, have been subjects of previous investigation but without substantial results from the standpoint of the quarantine or control.

When the quarantine was established in 1919, our state was hopeful that wart could be starved out in ten years. However, we had wart develop this year in gardens where no potatoes of any kind had grown since 1919. This experience has been repeated annually during the past thirteen years.

Clean and frequent cultivation was at one time announced as an effective control. Our experience indicates that cultivation does reduce wart, but will not eliminate it even when practiced over a period of six years. Thorough aeration is more effective but not practical.

We find that soil temperature is a vital factor. Seventy degrees Fahrenheit soil temperature appears to be the upper limit for wart development unless there is excess moisture present in which case we have had some development up to about seventy-two degrees Fahrenheit. This may have some bearing on the fact that wart is found in this country only in high mountain areas where soil temperatures are appreciably lower than in comparatively nearby valley areas. Field studies covering the period of April 15 to November 15, 1931, showed average soil temperature at Harrisburg to be seven to ten degrees Fahrenheit higher than at Hazelton and Ebensburg—the latter two in the elevated wart area—and well above seventy degrees Fahrenheit, the limit of wart development. We have observed, also, a marked falling-off of wart development in experimental plots the last three seasons due, no doubt, to the abnormal heat and lack of rainfall.

Soil sterilization has been studied for years and various effective materials have been demonstrated, but either excessive cost or detrimental effect on plant growth has prevented their adoption as a means of avoiding or eliminating the quarantine. During the past year we have hit upon a material which to date appears quite promising and the cost would not be beyond reason for quarantine purposes. Should this work out, we propose to treat infected gardens in small outlying areas, throw these areas open to planting of other varieties under permit but otherwise continue the quarantine with inspection of the growing crop and at digging time. If no other infections show up over a period of a few years, the quarantine would be lifted in these areas and we would proceed to treat other areas in the same manner.

Some such policy appears to be the only alternative for Pennsylvania unless some one develops or discovers an immune variety superior to our present Rurals and succeeds in having it adopted throughout the state. Even then, there would doubtless be sufficient susceptibles grown to keep potato wart a live issue with many of our growers.

Parasites of the Sunflower Weevil, *Desmoris fulvus* Lec., During 1931 and 1932. During the 1931 and 1932 seasons examinations of sunflower seed to determine the infestation by the sunflower weevil, *Desmoris fulvus* Lec., were carried on in Illinois. Records of parasitism are interesting if not of particular economic importance.

Parasites were found in 8 of the 11 lots of seed examined in 1931. Eleven specimens were reared. Of these 10 were *Microbracon mellitor* Say., and one was *Eupelmus cyamiceps* var. *amicus* Girault.

In the 1932 crop 2 out of 4 lots were found to contain parasites. The 2 not parasitized were obtained from a section where sunflowers have not been grown commercially. Nineteen parasites were reared from the 1932 crop, of which 18 were *Microbracon mellitor* Say., and one was a recently identified chalcid, *Trimeromicrus maculatus* Gahan.

The 2 species, *Eupelmus cyaniceps* var. *amicus* Girault and *Trimeromicrus maculatus* Gahan had not been previously reported as parasites of *Desmoris fulvus* Lec. Determinations were made by A. B. Gahan and H. H. Ross.

Since 1928 there have been 80 specimens of parasites of *D. fulvus* reared. Of these, 75 were found to be the *M. mellitor*. The greatest rate of parasitism, however, has been found as 6.2% in 1929. The economic value of the parasite is questionable.

J. H. Bigger, *Entomologist State Natural History Survey 1114 S. Main St., Jacksonville, Ill.*

THE STEM RUST CONTROL PROGRAM

By F. C. MEIER, *Principal Pathologist in Charge, Division of Barberry Eradication, Bureau of Plant Industry, Washington, D. C.*

Dread of a stem-rust epidemic, the sword of Damocles which hung over the head of the grain farmer in the upper Mississippi Valley during the agricultural development of much of that country is perhaps remembered within the personal experience of some of those present. Lodged and broken straw, heads of wheat filled with shriveled lightweight grain, much of which went out of the thresher through the blower with chaff and straw, were well known to those who experienced rust epidemics. In the early 1900's low yields from fields laid waste with rust, and price discounts on such poor quality grain as was harvested were not unusual, and in some cases finally meant the breaking up of homes and loss of land won by great hardship.

The story is well known, how, after we had lost some 200,000,000 bushels of grain in the United States due to rust during 1916, the farmers of North Dakota, following an example already set by their fellow grain growers in Germany, Denmark, France, and England, began a State campaign against the common barberry. This plant was known to be an intermediate host for stem rust, a host plant necessary to perpetuate the disease in northern climates and one on which the causal fungus multiplied abundantly in the spring. Among those present today there are men who in 1918 participated in organization of the Barberry Eradidication Campaign in the 13 North-Central States, Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming.

The magnitude of the task ahead was at that time not fully appreciated. Although the harmful common barberry is not native to the United States, it was popular with the early settlers who brought it from Europe. It was carried along with the movement of population westward. Barberries were carefully moved, in the covered wagons, from the eastern homes with other prized possessions. Later nursery salesmen gave away plants of this easily propagated shrub as inducements for purchase of orchard trees, as payment for a night's lodging, and as other good will offerings. The bright red berries borne by these bushes were attractive to birds which carried the seeds to out of the way places where new clumps of bushes were started. These were soon producing more seeds for spread by birds and other natural agencies. At the time the work of eradication began in 1918 no one knew the extent to which the shrub had escaped cultivation.

In spite of the many handicaps to the work in its early stages, hostility on the part of land owners and city dwellers not acquainted with the role played by the barberry in the spread of rust, the tremendous areas of escaped and fruiting bushes, the fact that exact location of

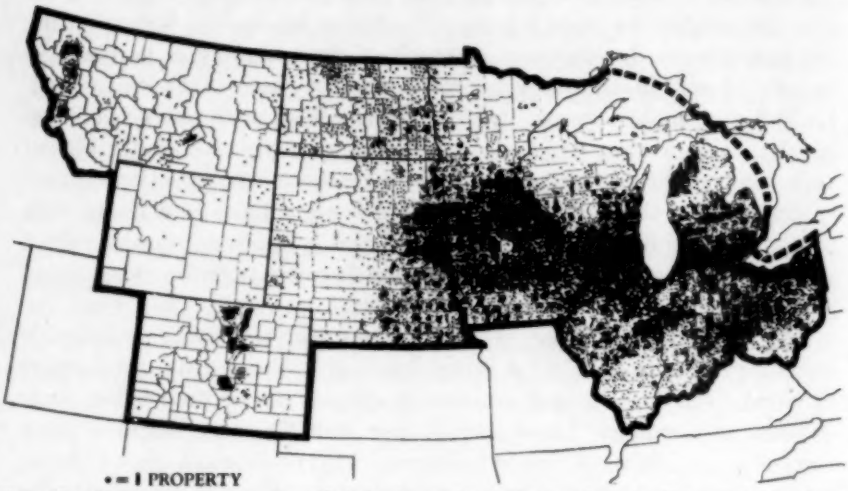

FIG. 48.—Rural properties on which barberry bushes were found, all surveys, barberry eradication, 1918–1931.

these areas are often unknown, and other difficulties, excellent progress has been made.

In the 14 years during which this campaign has been under way, approximately eighteen and one-half million rust susceptible bushes have been destroyed in the 13 North-Central and Western grain-growing States comprising the barberry eradication area. (Fig. 48.) That the eradication of these bushes has been accomplished by a decided decrease in rust losses is indicated by the following table.

LOSSES FROM STEM RUST DECREASE AS PROGRESS IS MADE IN BARBERRY ERADICATION

Wheat Losses Resulting from Black Stem Rust in 13 Northern States by 5-Year Periods		Rust-Spreading Barberry Bushes Destroyed Since Beginning of Stem Rust Control Program	
1916–20	285,000,000 bu.	1916–20	4,000,000 bushes
Average annual loss	57,000,000 bu.		
1921–25	85,000,000 bu.	1916–25	12,000,000 bushes
Average annual loss	17,000,000 bu.		
1926–30	45,000,000 bu.	1916–30	18,000,000 bushes
Average annual loss	9,000,000 bu.		

The eradication of the remaining barberry bushes should further reduce the severity, if not eliminate destructive epidemics of stem rust in the upper Mississippi River Valley. Furthermore, it will retard hybridization of physiologic forms of stem rust which takes place on the barberry leaves resulting in new forms of the fungus capable of attacking varieties of small grain that have previously proven resistant. As a result of past work, the remaining common barberry bushes are few and scattered in some States, while in others, such as Iowa, Wisconsin, Ohio, Illinois, and Michigan, there are many localities in which thousands remain.

The losses that continue to occur can be attributed to two causes: (1) The spread of rust from remaining barberry bushes, and (2) The development of rust in certain years as a result of spores carried by the wind from the Southern States where the red or repeating stage of the disease lives over the winter. Epidemiology studies made since the beginning of the barberry eradication campaign in 1918 have shown that in the Northern States the early development of stem rust and the most damaging epidemics of the disease are associated with the remaining common barberry bushes. However, during certain seasons when an abundance of rust is present in the South and wind, moisture, and temperature conditions favor the northward movement of spores, stem rust may develop in the spring-wheat area as a result of wind-blown inoculum. Rust from this source usually appears late in the growing season and is characterized by a scattered distribution over extensive areas. Unless crops are abnormally slow maturing, serious rust damage ordinarily does not occur.

The Division of Barberry Eradication and cooperating agencies are concentrating on attempts (1) to reduce the expense of finding the remaining barberries in those areas in which they are somewhat scattered, and (2) to reduce the cost of eradication in areas in which the bushes are numerous, particularly where they have escaped from cultivation. Progress is being made in developing the initiative of property owners and children with the result that more individuals each year become interested in stem rust control, learn to recognize the common barberry, and realize the necessity for eradicating it.

Cooperation Brings Success in This Project.—The present degree of success in the enterprise has been possible only as a result of whole-hearted cooperation by all parties concerned.

From the beginning, State Departments of Agriculture in all 13 of the States have been active in work of developing plans for the campaign. State Legislative assistance was prompt. The essential part played by State enforcement agents is well known to those present.

Practical assistance from State Legislatures in the form of direct cash appropriations to supplement Federal funds is part of the program. In one year or another since 1918, all of the important grain-growing States in the area have made substantial appropriations. At the close of the fiscal year 1932, Michigan had made appropriations 12 years out of 14. Wisconsin had made cash appropriations every year. In total amount in these 14 years, Michigan led with $58,400 while Minnesota was a close second with a total of $56,500. From North Dakota, the total for 14 years was $40,000. These direct contributions of cash from State Legislatures have been materially supplemented by contributions from millers, grain dealers, railroads, and other commercial agencies who have maintained the Conference for the Prevention of Grain Rust with an office in Minneapolis, now so ably managed by Mr. Donald G. Fletcher, Executive Secretary of that organization. In the first 14 years the Conference contributed $262,000 in cash.

Outstanding among State organizations that have given continuous support to the program are the Greater North Dakota Association and the North Dakota Retail Merchants Association. With wheat contributing a large share of the State's income and stem rust one of the chief causes of crop failure, these organizations were quick to take advantage of the opportunity to help rid the State of the rust-spreading barberries.

To the cash contributions from the States and the Conference must be added indirect aid in the form of office space, in some cases automobiles, and services of State employees. All States have contributed in this way. Total contributions in cash and services from State and other agencies for 14 years have amounted to $1,101,887. During this period total appropriations of the Federal Government have amounted to $4,449,775. The total of all money spent for barberry eradication to date is less than 1/10 of the average annual loss from stem rust during the 5-year period 1916–1920.

Cooperation of nurserymen is essential to the success of the program. It would of course be futile to spend large sums of money for eradicating barberries and leave the door open for others to come in. From the beginning of the work nurserymen have taken a sympathetic attitude. Quarantine inspection under Quarantine 38 (Revised) is giving increased personal contact with the larger nurseries, and as nurserymen find the Department representatives helpful in the matter of identifying barberry species, and suggesting uses for the less well known resistant plants, they are making every effort to aid in the program.

State officials have from the beginning understood the desirability of giving service to nurserymen. An example of this was the request received last spring from Mr. C. W. Ellenwood, Chief of the Bureau of Plant Industry of Ohio for a paper on uses of non-rust susceptible varieties of barberry which might be distributed to the Ohio State Nurserymen's Association. This paper, prepared by our Mr. B. Y. Morrison, who for a number of years has studied the barberries from a horticultural viewpoint was well received. There are many opportunities for such service to nurserymen in the course of our program for securing their aid in preventing the distribution of rust susceptible barberries.

Likewise cooperation of the public schools, 4-H Clubs, Future Farmers of America, the Boy Scouts, and other organizations of young people is important. By work with these groups we are enabled to find unknown locations of barberries with much less expense than formerly when it was necessary to systematically scout all areas. Now to an increasing degree, we are led to locations of bushes by reports from school children. As a natural result of the spread of information concerning stem rust, it is rarely the case that instances of opposition to barberry eradication are encountered. Instead there is an increasing interest on the part of adult farmers which leads to their taking part in the work of eradication.

It is by cooperation of the Extension Service in the 13 States that we have had assistance from the county agents in making local contacts and developing local plans of work. During the past two seasons when more labor has been employed locally for eradication effort, these joint representatives of the Department of Agriculture, the States, and the counties have been especially helpful.

Specific instances of cooperation of organizations and individuals are too numerous to be mentioned in the time available. Many agencies other than those mentioned have lent their support to the project.

THE DIVISION OF BARBERRY ERADICATION.—So much for some of the cooperative features of the work. Within the Department of Agriculture this project, originally organized by representatives of the Office of Cereal Investigations, is now administered as a separate Division. In spite of the large area covered, the plan of organization is simple, involving a minimum of overhead expense. No regional offices are maintained. Instead the Washington office deals directly with ten field offices located in or near State College or University buildings.

Summing up activities of the Division they are in brief: (1) Research to provide a sound basis for procedure by determining the factors influencing the occurrence and spread of the stem rust fungus, to improve methods of eradication, and to classify species and varieties of the bar-

berry according to their degree of susceptibility to rust; (2) Informational work intended to instruct grain growers and other property owners in the application of practical measures for reducing the stem rust hazard in the production of crops; (3) Service in eradication of barberry bushes in locations where they are numerous or where stem rust recurs year after year to a damaging extent. It is in the phase of research dealing with classification of barberries, susceptibility tests, and nursery contacts that many of those present today are particularly interested.

SERVICE TO NURSERYMEN.—In the administration of Quarantine 38 (Revised) there are now on the list of barberries which are immune or sufficiently so to warrant their distribution in the wheat-growing States 29 species, varieties, and hybrids. Best known of these is the popular Japanese barberry (*Berberis thunbergii*). Among the rust resistant evergreen plants are *B. repens*, *B. aquifolium*, *B. darwinii*, *B. triacanthophora*, *B. verruculosa*, and *B. sargentiana*. Study of the plants which may safely be distributed without risk to grain growing regions, convinces one that the restrictions of Quarantine 38 (Revised) need entail no hardship on nurserymen because there are a number of very desirable species known to be entirely immune from or highly resistant to black stem rust.

Inspection activities under supervision of the Bureau of Plant Quarantine bring to light the fact that many nurserymen do not yet understand the quarantine. Many of these men are anxious to know which barberries they may grow. Extension of inspected and approved nurseries will encourage more nurseries to join the list of those growing immune plants only. The certified nurseries are at an increasing advantage. In 1931, thirty-one nurseries were inspected in eleven States. Twenty-three were approved after destruction of any susceptible plants found by the inspector on the premises.

DEFINITE PROGRESS MADE IN RUST CONTROL STABILIZES PRODUCTION.—In closing it is desired to emphasize the fact that decided progress has been made in removing barberries from the 13 States of the eradication area and in laying a ground work to prevent their return. As progress has been made in eradication, stem rust losses have decreased. This progress was made possible by continuous effort on the part of States concerned, farmers organizations, business men, and individuals who have continuously cooperated with the United States Department of Agriculture. Within this group there are State representatives who have taken an active part in the program.

I was very much interested in a statement made to me recently by an

agricultural statistician of the Department to the effect that from the Crop Reporting Board's standpoint the precision of probable wheat production in North Dakota on July 1 is very much increased because excessive shifts in the probable yield per acre, due to the degree of rust damage, have been eliminated. This statement is more or less suggestive of what has occurred in several of the Western States where barberry bushes are now few and scattered.

CONTINUED COOPERATION ESSENTIAL.—The very fact that stem rust epidemics have become fewer and less severe during the past several years may tend to slow up the work. There is always the danger of a tendency to slacken control efforts when immediate danger of destructive epidemics seem to have passed. Remembering that while only scattered bushes remain in certain States, in others extensive areas of escaped seeding bushes are still to be found, it is clear that a steady drive must be made to gain barberry-free territory and to prevent reinfestation of land from which bushes have been removed.

The effectiveness with which this may be done will depend on continued effort of the Federal and State Governments in locating and destroying remaining bushes, increased cooperation of schools and other informational agencies, the State support given the project in the form of cash appropriations and the continued organized effort of State Crop Disease Control agencies. Past achievements give confidence that this most extensive of all plant disease control projects yet undertaken is coming through to success not only as a rust control measure but as an outstanding example of cooperative effort.

PROGRESS IN PHONY PEACH DISEASE ERADICATION

By WILLIAM F. TURNER, *Agent, Phony Peach Eradication, Bureau of Plant Industry, U. S. Department of Agriculture*

ABSTRACT

The phony peach disease is an infectious systemic disease for which no cure of the diseased tree is known. It is now known to occur in twelve Southern States and in Illinois. It is generally present and severe in Georgia and South Alabama; during the last few years more than a million trees have been either pulled or abandoned and many growers have been forced out of production. Individual cases are widely scattered throughout all of the other Gulf States but its results in these areas are not yet commercially destructive; very few infections have been found in the remaining states, namely Oklahoma, Arkansas, Missouri, Tennessee, South Carolina, North Carolina, and Illinois. An eradication campaign was begun, in 1929, by the Federal Department of Agriculture, in cooperation with the State of Georgia, which at that time was the only state in which the phony disease had been recognized. This work has been continued and extended to all areas now known to be infected.

Confronted with the problem of controlling a disease that threatened the very existence of the entire peach industry of the United States, having already taken such heavy toll in the most concentrated peach district in the East that over a million trees had been pulled up in three years and many growers had been forced out of the industry; a systemic

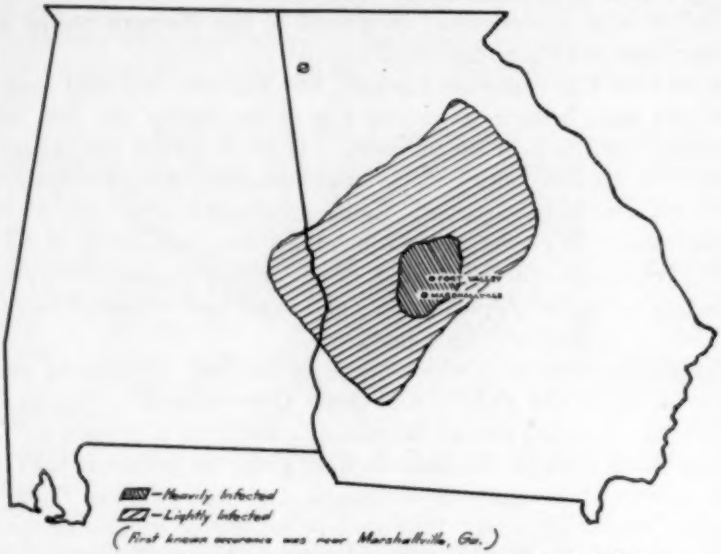

FIG. 49—Phony peach disease, known distribution in 1928.

disease, moreover, for which no cure had been found and which belonged to a class of diseases known, in part, for over one hundred years and for which there was no known remedy except the destruction of the host; in 1929, the Federal Department of Agriculture, in cooperation with the Georgia State Board of Entomology, undertook to check the spread of the phony peach disease and, if possible, to eliminate it by means of an eradication campaign.

DISTRIBUTION OF THE DISEASE.—Preliminary surveys, necessarily limited in extent since only two men were available for the work, had indicated a generally severe outbreak throughout the Southern Peach District of Georgia; a lighter distribution through the Middle Georgia District and only an occasional phony tree in North Georgia. A few diseased trees had also been found in Lee County, Alabama—an area contiguous to the Middle Georgia District. (Fig. 49). Consequently, during most of the first season, work was confined to an attempt to inspect as many as possible of the commercial orchards in the area known to be involved.

Some scouting work, undertaken near the close of the season, brought to light a severe local outbreak in Western Alabama and another in Central Mississippi. Since 1929, therefore, the actual eradication work has been supplemented by numerous surveys that have at least touched all of the commercial peach growing districts east of the Mississippi

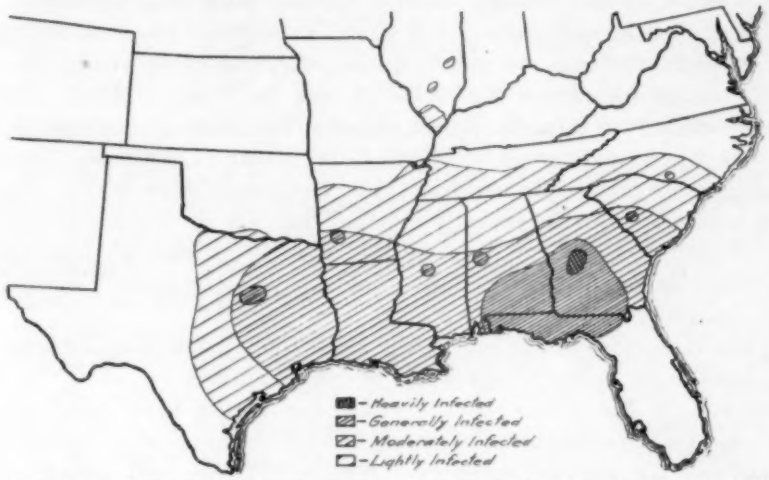

FIG. 50.—Phony peach disease, present known distribution, January, 1, 1932.

River as well as those of the states of Louisiana, Texas, Oklahoma, Arkansas, Missouri and Kansas to the west. With such a wide area to cover and with only a limited personnel available for this work, the scouting could not possibly be very intensive. However, it has shown that the disease occurs in at least thirteen states—North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Illinois, east of the Mississippi River and in Louisiana, Texas, Arkansas, Oklahoma, and Missouri to the west of it. (Fig. 50).

The phony disease is most severe on the Fort Valley Plateau, in Georgia; an area extending from Bibb County on the north to Montezuma, in Macon County, on the south and from Eastern Crawford County, easterly about half way across Houston County. Incidentally this was, until recently, the most intensively planted peach district in the Eastern United States and it was on this plateau that the first phony peach trees were found.

The remainder of the infected territory grades rather satisfactorily itno three regions on the basis of intensity of infection, and we are designating these as Generally Infected, Moderately Infected, and Lightly Infected Territories. In the Generally Infected Territory very few

commercial orchards five years of age or older were free from the disease at the beginning of the campaign and the incidence sometimes ran as high as 25% in individual orchards. In addition, a considerable proportion of the home orchards were also infected. This territory covers Southern Georgia and South Alabama.

In South Carolina, Middle Georgia, Central Alabama, Mississippi, Louisiana, Southern Arkansas, and East Texas phony trees are found rather widely scattered, the infection being very moderate, except for a few secondary foci where the incidence may be severe. Many commercial orchards in this Moderately Infected Territory are entirely free from the disease and outside of Middle Georgia only an occasional home orchard tree is phony. In certain Middle Georgia counties in this area, home orchards are more severely infected than are the scattered commercial plantings and it is possible that if such commercial plantings were more numerous these counties would have to be classed as Generally Infected.

In the remainder of the infected territory only a few diseased trees have been found, either in commercial or small plantings.

Inspection Methods.—In the main, our efforts have been concentrated on the eradication of phony trees from commercial orchards throughout the infected territory. During 1929 we had fifteen inspectors who worked five months, and ten who worked three months. Work was confined to Georgia and one county in Alabama. In 1930, thirty-eight men were employed for five months and inspections were extended into Tennessee, Alabama, and Mississippi. In 1931, with the same forces, many orchards in North Carolina, South Carolina, Tennessee, Arkansas, Louisiana, and Texas were also covered. During the past season, much the same territory was inspected, but less thoroughly, by a force of eighteen men.

We have found that best results follow where the inspectors work in squads of from three to five men—depending on the size of the orchards and their concentration. During the first year, we tagged many of the trees, under an agreement with the owner which stipulated that he would pull them up. The actual removal of these trees was not accomplished, in many cases, until the following winter, and it was necessary to make one or more trips to the orchard in every case in order to obtain a record of such removal. Finding that a very large percentage of the trees die when the main limbs are cut off during the period of inspection (June through October), we now cut all phony trees in this manner. The work takes very little more time than does tagging and saves the cost of tags and the expense of further trips to the infected orchards.

WORK DONE.—Table 1 summarizes the eradication work done each year, listing the number of commercial orchards covered, the number of trees inspected, and the number of phony trees found.

TABLE 1. INTENSIVE INSPECTIONS IN COMMERCIAL ORCHARDS

Year	No. Orchards worked	No. trees inspected	No. orchards found infected	No. phony trees destroyed
1929.....	1,472	7,574,304	816	81,042
1930.....	2,554	11,986,543	1,256	217,084
1931.....	3,221	9,529,450	659	37,721
1932.....	1,310	4,786,007	442	34,465
Total.....	8,557	33,876,304	3,173	370,312

In considering the economic importance of a disease we naturally think in terms of commercial plantings and, as I have stated, our efforts have been devoted largely to the elimination of the phony disease from such orchards. However, from the standpoint of eradication, home orchards and even wild trees may play as important a role as do the larger plantings.[1] In fact, in many counties, our only records of the presence of the disease are based on infections found in such home orchards. More than this, in a few cases, repeated inspections in commercial orchards have indicated the presence of a source outside such orchards, from which the disease was continually re-invading them. For these reasons we have conducted a few intensive home orchard surveys, using a county as a unit, and the inspectors are instructed to stop and cut such phony trees as they may see in home orchards, when traveling from one commercial orchard to another. In general, this work has indicated that from one district to another, the incidence in home orchards varies in about the same way that it does in commercial orchards, the percentage of infection in any one community usually being lower than that in commercial orchards in the same community. However, there are numerous exceptions to this general rule, especially in counties

TABLE 2. INTENSIVE INSPECTIONS IN HOME ORCHARDS

Year	No. orchards worked	No. trees inspected	No. orchards found infected	No. phony trees destroyed
1929.....	14	665	4	19
1930.....	5,052	150,047	825	3,391
1931.....	2,127	43,018	290	1,316
1932.....	4,044	89,176	473	1,602
Total.....	11,237	282,906	1,592	6,328

[1]Since plantings vary all the way from one tree to several thousand, no hard and fast line can be drawn between "commercial" and "home" orchards. For various reasons of economy in operation and uniformity in keeping records, we have made an arbitrary division, considering all orchards of less than 100 trees as home orchards and all those of 100 trees or more, as commercial orchards.

where there are thousands of trees in home orchards but where there are very few large plantings. Table 2 summarizes the work done in home orchards.

Table 3 summarizes the results of the scouting work in a similar manner.

TABLE 3. EXTENSIVE SCOUTING

Year	Number observations	Number trees	No. places found infected	No. phony trees
1930.....	8,338	121,579	26	55
1931.....	7,329	2,558,626*	1	2
1932.....	282	7,261	1	1
Total.....	15,949	2,687,466	28	58

*Includes many commercial orchards scouted in 1931.

It should be borne in mind that no comparisons of results can be drawn from Tables 1, 2, and 3, since in no one year have we exactly duplicated the inspections made in any other year. The tables are presented simply as a record of work performed since the beginning of the campaign.

RESULTS.—While we are now able to operate much more expeditiously than was the case at the beginning of the campaign, it has never been possible to cover all of the orchards during any one inspection season. Consequently, comparative figures, showing the results that have been accomplished, can be furnished for only a small proportion of the orchards inspected. Examples are furnished from the two extremes of infection—very light and very heavy.

Table 4 gives the figures for 289 orchards, located in 20 counties in the Lightly Infected Area of North Georgia. In these orchards three years of eradication reduced the number of phony trees 84%.

TABLE 4. REDUCTION OF PHONY TREES ACCOMPLISHED BY THREE INSPECTIONS IN LIGHTLY INFECTED TERRITORY (289 ORCHARDS—629,413 TREES)

Inspection	No. orchards infected	No. phony trees	Per cent decrease yearly	Per cent decrease to date
1929.....	20	44		
1930.....	11	19	56.82%	56.82%
1931.....	6	11	42.11%	75.00%
1932.....	6	7	36.27%	84.10%

During the first year we were not able to reach the most Heavily Infected Area, on the Fort Valley Plateau. Consequently, figures are available for only three inspections, showing the results obtained by two years of eradication. In 127 orchards, located in four counties, we have reduced the number of phony trees 66%, as shown in Table 5.

TABLE 5. REDUCTION OF PHONY TREES ACCOMPLISHED BY TWO INSPECTIONS IN HEAVILY INFECTED TERRITORY (127 ORCHARDS—911,550 TREES)

Inspection	No. orchards infected	No. phony trees	Per cent decrease yearly	Per cent decrease to date
1930.....	126	50,544	———	———
1931.....	126	25,793	48.97%	48.97%
1932.....	121	16,815	34.85%	66.74%

We feel that the figures, as given, indicate that very distinct progress has been made and the results obtained by the second and third inspections are particularly encouraging. From the standpoint of eradication, one of the most outstanding characteristics of the phony disease is its long incubation period. By careful and often repeated experiments, Dr. Lee M. Hutchins of the Federal Bureau of Plant Industry, has shown that after artificial inoculation, performed during the winter months, this period is at least eighteen months long and there is much evidence to indicate that under conditions of natural infection the period is probably extended to at least two years. Hence, following the removal of all positive cases by a first inspection, all of those trees showing the disease a year later had already been inoculated before eradication was started. In other words, it was only when we had inspected an orchard for the third time that we had figures that would indicate a definite advance in our control of the disease. In Table 4 it will be seen that in Lightly Infected Territory an average reduction of 42.11% was indicated by the third survey; these results being supported by a further reduction of 36.37% the following year. In Heavily Infected Territory (Table 5) we have obtained an average reduction of 34.85% of new cases to date.

All who are familiar with eradication work will realize that these average figures are by no means applicable to every individual orchard. In a few cases our inspections have indicated a lack of results due, apparently, to constant re-infections from some source outside the orchard under consideration. During the last two years we have been able to survey the territory closely surrounding a few such orchards. In every case we have investigated, we have found one or more groups of trees, either in home orchards or growing wild, rather closely adjacent to the commercial planting and heavily infected with the phony disease.

One case may be cited as an example. In Fayette County, Georgia, we have inspected one orchard of 25,000 trees for four years, commencing in 1929. The orchard was planted in 1926. The first year we found 19 phony trees. In 1930 we found 3. In 1931, at the third inspection, we were surprised to find 119 phony trees. An analysis of the situation showed that all but 26 of these trees were located in the western portion

of the orchard, 53% of them occurring in the first 10 rows. (Fig. 51). We immediately made an intensive survey of home orchards and wild trees, finding 279 phony trees within one mile of the orchard. These

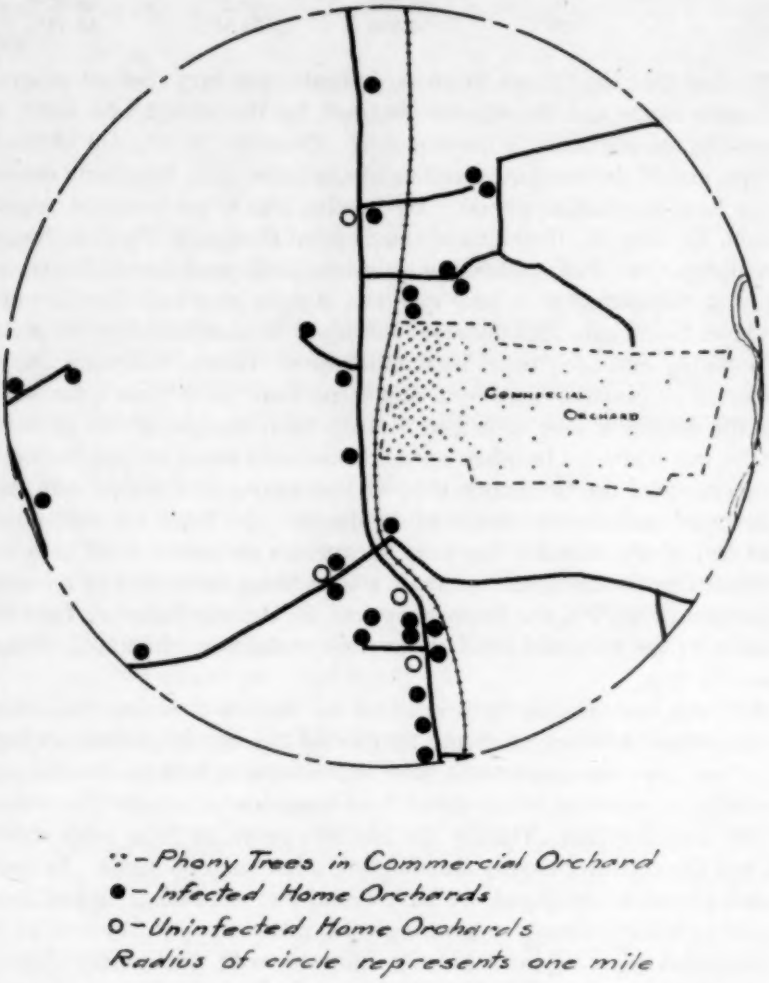
Commercial Orchard
∵ - Phony Trees in Commercial Orchard
● - Infected Home Orchards
o - Uninfected Home Orchards
Radius of circle represents one mile

FIG. 51.—Phony peach disease, infection of a commercial orchard from surrounding home orchards.

were destroyed. This year, at the fourth inspection, we found only 42 phony trees in the orchard.

The phony disease situation is a complicated one. Conditions vary

widely in different parts of the territory affected. While commercial control, involving only the larger orchards, is obviously of primary importance, biological control is only possible through the examination of every peach tree in the infected area. Commercial plantings are of very uneven distribution and in many large areas the continuance of the disease is wholly dependent upon infections in small home orchards or even in wild trees. Purely local conditions are frequently of such importance as to produce results entirely out of line with those obtaining in other, apparently similar, areas. Under such circumstances, an attempt to show the exact situation by figures would be confusing. However, our observations, over all of these varying conditions, lead us to believe that there has been a very decided gain of eradication of disease over incidence of disease. While we consider this trend as very definite, the work has not yet progressed far enough to allow us to predict the time when the disease can be completely eradicated.

CHAIRMAN PRICE: The report of the Resolutions Committee will be presented by Mr. A. F. Burgess.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Your committee wishes to express the thanks of this Section to the Local Committee for the ideal arrangements that have been made for holding this meeting and to express our appreciation of the interest of the members who in many cases have gone to much personal inconvenience and expense to make the session so successful.

A. F. BURGESS
E. L. CHAMBERS
C. H. HADLEY
Committee

On motion the report was adopted.

CHAIRMAN PRICE: Doctor Britton will present the report of the Committee on Nominations.

MR. W. E. BRITTON The Nominating Committee makes the following recommendations:

Chairman: R. W. Leiby, Raleigh, N. C.
Secretary: S. B. Fracker, Washington, D. C.

W. E. BRITTON
G. M. BENTLEY
Committee

On motion the report was adopted and the officers named declared elected.

The meeting adjourned at 5 o'clock.

Section of Extension, American Association of Economic Entomologists

Friday morning, 9:30, December 30, 1932

The Program was scheduled for 1:30 p. m., but was changed to 9:30 a. m., so as not to compete with the Deciduous Fruit program in the general section, in which many of the Extension Entomologists were vitally interested.

The Committee on Nominations, appointed by the Chairman, consisted of P. D. Sanders, W. E. Blauvelt, and C. C. Wakeland, The Committee recommended, and the section elected as Chairman for 1933, H. E. Hodgkiss, State College, Pa., and as Secretary, M. P. Jones, Washington, D. C.

The Committee on resolutions, consisting of W. A. Price, H. G. Walker, and J. J. Davis, presented resolutions that were unanimously adopted as follows:

RESOLUTIONS

WHEREAS, the arrangements for the meeting of the Extension Section of the Association were most satisfactory.

Be it Resolved, That we express to Messrs. T. J. Headlee, and C. H. Hadley, our deep appreciation of their services in this connection, and to the American Association of Economic Entomologists for their cooperation in providing suitable facilities for the program.

(Signed)
H. G. WALKER
J. J. DAVIS
W. A. PRICE, *Chairman*

THE ROLE OF THE EXTENSION SERVICE IN COMBATING GRASSHOPPERS

By A. D. WORTHINGTON and A. M. PEARSON

ABSTRACT

The Extension Service, in cooperation with the Agricultural Experiment Station and the State Department of Agriculture, conducted successful grasshopper campaigns in Iowa in 1931 and 1932. The program adopted and the methods used are briefly described. Commercially prepared poison bran bait was used almost exclusively in the control work. Community cooperation of the farmers in spreading the bait was excellent.

The purpose of this paper is to describe briefly the methods used in controlling grasshoppers and to emphasize the results that may be

secured when the Extension Service, in cooperation with the State Entomologist and Experiment Station, put into operation a well planned and organized grasshopper control campaign.

For several years the grasshopper population has been increasing rapidly in Iowa and in the adjoining states to the west and north. The center of the infestation was probably located in South Dakota. The present outbreak has been largely the result of an over-abundance of two species, the differential (*Melanoplus differentialis* Thomas) and the two striped (*Melanoplus bivittatus* Say) grasshoppers. The red legged (*Melanoplus femur-rubrum* DeGeer) and the lesser migratory (*Melanoplus mexicanus* Saussure) grasshoppers have also done considerable damage. Poison bran bait was used for their control in seventy-one counties.

Conditions during the summer and fall of 1931 were unusually favorable for grasshopper development and permitted oviposition over a long period. Field observations and surveys in the fall of 1931 showed immense numbers of egg masses, particularly in the western part of the state. There seemed very little doubt that a serious grasshopper outbreak would occur again the following year. This prediction was verified in March 1932 when field observations indicated that a large percentage of the eggs had survived the winter without apparent injury.

The first measure taken in 1932 was the formation of a state-wide organization. A state committee consisting of M. G. Thornburg, State Secretary of Agriculture, R. K. Bliss, Director of Extension Service and Dr. C. J. Drake, State Entomologist was appointed. This committee selected the State Entomologist as state leader in the control campaign, who in turn appointed the Extension Entomologist and his assistant to organize, and supervise the field work. In each county the agricultural agent was made county leader to organize his county in cooperation with the Extension Entomologist. In the seriously infested counties a committee, composed of local bankers, newspaper editors, members of civic organizations, directors of Farm Bureaus and other influential persons, assisted the county agent. In communities where grasshoppers existed in great numbers, a leader was selected by the county agent to assist in organizing and conducting demonstrations in his community.

The State Committee secured state funds for purchasing and handling the poison bait and made it available to all counties where organizations were formed for handling the bait. Bids were received from several commercial concerns; contracts were awarded three firms (located in Des Moines, Sioux City, and Omaha respectively) to furnish ready mixed poison bait. The bait used consisted of 80 per cent bran, free of

shorts, 15 per cent black strap cane molasses and 5 per cent finely powdered white arsenic. The county leaders ordered poison bran directly from the State Secretary of Agriculture. The state paid all transportation charges on shipments of five ton lots or more to county and community distributing points. In all communities a local grain elevator company stored and distributed the poison bran without commission or profit. The state sold the poison bait to the farmers and growers at 50 cents per hundred pound bag. This small charge prevented the wasting of the bait and insured care and precaution in its distribution. A farmer who wished to obtain the bait secured an order from his county agent, or from some person appointed by the agent, and obtained the bran from the nearest distributor.

At district meetings held in the early spring the county agents were given detailed instructions relative to their duties during the campaign. Briefly, the duties of the agents were to organize their counties, to give publicity to the program, to make periodic county surveys, to order, store and distribute the bait, to arrange, advertise and conduct field demonstrations, and to make individual calls and interviews with farmers whenever necessary. The cooperation of the county agents and the local committees was very gratifying to the Extension Entomologist and to the State Committee.

Field demonstrations were a valuable means of instructing the farmers; they also served to stimulate them to take early and proper control steps so that a large percentage of the grasshoppers were poisoned on their hatching grounds. For all demonstrations and control in waste areas the bait was furnished free by the state, providing it was applied by the community and the adjoining privately owned fields had been treated. The field demonstrations were advertised through local newspapers, post cards to Farm Bureau mailing lists, posters, and by various other means. Field demonstrations consisted of short talks on grasshopper habits and control, followed by detailed demonstrations on mixing and spreading the poison bait.

Several methods of scattering the bait proved practical. For small areas, sowing by hand while walking, or on horseback, was found to be quite satisfactory. For larger areas an endgate seeder seemed to be one of the most efficient and generally used methods of application. As an endgate seeder was available on nearly every farm, it could be operated without any additional investment on the part of the farmer and the bait could be applied rapidly. The airplane also proved to be efficient in scattering poison bran for both grasshoppers and armyworms in waste areas and on large infested fields.

The proper functioning of the program depended very largely upon the efforts of the Extension Entomologist. His duties were many and varied. It was necessary for him to make field surveys throughout the season and to determine the areas needing control measures. He promoted publicity regarding the program, progress and interesting features of the campaign. Cooperation and interest in the program depended much upon well planned and timely publicity. The initial demonstrations in a county were conducted by the Extension Entomologist or his assistant. At such demonstrations the county agent and local leaders became familiar with the proper methods of preparing and applying the poison bait. It was necessary for him to be in the field continuously to direct the distribution of the poison bran to the counties in accordance with their needs, in order to prevent an excessive carry-over. He was also continually called upon in the field to determine the effects of fungus diseases and parasites and to issue free bran for waste areas. False rumors in regard to the effectiveness of diseases and the ineffectiveness of the poison bran were sometimes started and it became the duty of the Extension Entomologist to investigate such rumors, give an adequate explanation and stop the false rumors. For example, the mayor of a small town in Sioux County, who was also an extensive farmer, secured fungus cultures from a nearby state and some twenty farmers used it. Within a few days after the fungus was introduced reports were published in state and county papers regarding the wonderful results secured by this method. The local promoter of this fungus control project gladly directed the Extension Entomologist to these twenty farms to make an investigation. Apparently the fungus had not caused the death of a single grasshopper. The mortality that had been accredited to the fungus was in reality being caused by parasitic flies in a few localized areas. The community immediately obtained a shipment of poison bran and in a short while the grasshoppers were well under control.

The heaviest infestations were somewhat localized in the western part of six counties along the Missouri and Big Sioux Rivers; 250 tons of poison bran bait were distributed in these counties. In this area over 99 per cent of the farmers having grasshoppers in sufficient numbers to cause damage used the bait. Due to early and timely control measures the grasshopper damage did not exceed 10 per cent of the crop in any field. In Woodbury County alone 475 farmers cooperated in distributing poison bran. The control of the grasshoppers was not the only beneficial result of the campaign, as farmers who had not previously been wholly in sympathy with the Extension Service were induced to

cooperate in extension work through the medium of the grasshopper campaign.

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F. D. BUTCHER: Minnesota had an outstanding grasshopper control campaign this past summer. About 56 counties were well organized. The form of organization was similar to that outlined in this paper.

VEGETABLE INSECT SCOUTING IN NEW JERSEY[1]

By ROBERT C. BURDETTE, *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Systematic scouting of vegetable crops for beginning of insect outbreaks, as practiced in New Jersey, was discussed. The object is to forestall outbreaks and make better control possible. The results secured were discussed, tomato horn worm being taken as an example.

For many years in New Jersey, outbreaks of insects on vegetables have occurred which have caused an almost complete loss to the affected crops in certain localities. A study of these outbreaks has led us to believe that the main cause for the severe losses was due to the lack of information on the early appearance of the insects causing the damage. Usually three-fourths of the damage was accomplished before any real effort to control the insects had been started. The growers should necessarily be made to realize the need for action sufficiently early to

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

prevent serious damage to their crops. The insects in some cases are so small that they pass unnoticed by the grower until the plant crops begin to exhibit physical characteristics of an abnormal nature. Unfortunately, by the time these abnormalities appear half or more of the damage had already been done.

It was with the idea of finding the appearances of injurious insects sufficiently early to enable the grower to protect his plantings that vegetable insect scouting was started. The work did not get under way this past summer until the first week in June. As we have no extension entomologist in New Jersey the writer undertook the scouting work in connection with the research program on vegetable insects.

Two days of each week were allotted to this work and the area to be scouted was confined to the southern portion of the state which is the principal vegetable growing area. The principal objects of the scouting trips were (1) to find the beginnings of insect outbreaks, (2) to follow up such beginnings and (3) to give control information.

The various vegetable crops were gone over carefully for the absence or presence of insects. A comparison was made in relation to abundance of insects each week to that of the previous week. This was done by making counts in various parts of the fields. In this way increases and decreases were readily obtainable and comparatively accurate information was then at hand for dissemination. Fields were considered where control measures were applied as well as fields where nothing was being done to prevent the insect damage.

After the scouting trip was finished a report was written up containing the information found that particular week. This report contained the status of the insects on each crop in relation to the previous week, with recommendations as to control measures and the time when these control measures should be used. This report was typewritten and a copy sent to each county agent in the state and to certain large vegetable growers and canners. The scouting was continued until the last week in August.

The scouting trips gave a very good idea of the insect situation on vegetables throughout the summer. The tomato horn worm has for several years been a serious problem in our state but with this early information we were able to control the tomato horn worm better than in previous years.

As an example of the scouting report, one can take the tomato horn worm. The eggs and small larvae were found on June 20th and 21st and the infestation was in only four of the counties scouted. The report contained recommendations for controlling the insect and also

advised prompt application of control measures. The scouting the following week showed a heavier infestation with more eggs and young larvae, but also larvae 1½ inches long. At this time the horn worm was found on peppers in two counties. The third week found serious damage to unprotected fields with little or no damage to protected fields. Eggs and young larvae were also reported. The fourth week few eggs were found but many larvae ready for pupation were seen. The fifth week showed larvae present but no eggs. Damage was very heavy in unprotected fields, and some damage to sprayed fields where spraying was poorly done. The sixth week showed about the same conditions as the fifth week. The seventh week, August 2nd and 4th, eggs of the horn worm were found in small numbers. The eighth week the scouting found the eggs in larger numbers than the previous week and also young larvae. Prompt treatment of the tomato was then advised for this second brood of horn worms. The ninth week showed eggs and larvae much more numerous than the previous week and considerable damage was present in the field. The tenth week showed many of the worms more than half grown. At this time heavy parasitism was found in one field. No further follow up was made after this time due to other work.

We also had at our finger tips the various stages of other insects during the summer and could then revise our control recommendations to fit the changing conditions. Each county agent then knew the stages and populations of various insects in his county so that control measures were not being stressed until conditions were favorable. The scouting more or less eliminated the haphazard method of sending out service cards on control measures for an insect over the entire state. The service card method as used heretofore to be in time for a certain section of the state has been too early for one section and in other sections too late. With the scouting service, timeliness of spray applications could be greatly stressed.

No attempt was made to organize campaigns against the insect and to follow up control measures only as such came under observation while making the regular scouting trip.

It was felt that organization or campaigns should be carried out by the county agents with such help as was needed when time from other duties was available.

The county agents usually followed up the reports and checked the information themselves. This information was well received and the measures adopted early enough to prevent serious outbreaks.

SPRAY SERVICE FOR VEGETABLE CROPS[1]

By L. H. SHROPSHIRE, *Assistant Entomologist, State Natural History Survey*

ABSTRACT

A spray service developed in the intensive trucking area around Chicago was described. It is carried on in connection with research work, and includes scouting to warn of outbreaks; dissemination of control information by publications, meetings and newspaper articles; and aid in securing dependable insecticides and fungicides.

Losses from insect injury constitute one of the largest items of expense in vegetable production. In Illinois alone it is estimated[2] that this loss reaches a total of four or five million dollars annually.

Since the largest vegetable growing area in Illinois is that around Chicago, in Cook County, it is here that most of the experimental work on truck crop insects is carried on. Headquarters are established at the Cook County Experiment Station, a branch of the Illinois Agricultural Experiment Station, located at Des Plaines in the heart of the vegetable growing area. Field work is done in connection with the regular research work on insect pests. The spray service for vegetable crops has developed in connection with field and research work in the northern part of the state, the Illinois Natural History Survey cooperating with the Department of Horticulture of the University of Illinois and its Extension workers. In Cook County, the Farm Bureau under the direction of the Farm Adviser and the Cook County Truck Growers Association, an independent organization of growers, are actively sponsoring the insect control program for vegetables.

Scouting is a part of the regular field activities and has a two-fold objective: (1) that of keeping informed as to insect activity, and (2) that of keeping in touch with the growers and their problems in using the methods recommended to them for insect control. Both phases of this work are very necessary. An average of one day each week is devoted to field work, dividing the time as necessary between scouting and investigating reports of insect injury. Notes kept furnish a record of species, abundance, injury, parasitism, and other natural factors that may be of interest.

The method of reporting insect abundance depends to some extent upon the nature of an individual case. If the insect is a common one that has to be controlled every year, the matter of reporting abundance

[1]Contribution from the Illinois Natural History Survey, Entomology Project Group 7.

[2]Compton, Charles C. Insects Feeding on Truck and Garden Crops and How to Control Them. Ill. Agr. Exp. Sta. Circ. 391: 2. 1932.

is not as important as emphasis placed on proper and timely control methods. In the case of unusual outbreaks that threaten a crop, information may be reported to Farm Advisers or given to a selected group of newspapers in the form of news articles, briefly describing the insect, its habits, and giving the best method for its control.

Several methods are used in disseminating information for insect control. Bulletins and circulars on insects affecting vegetable crops are valuable and have a wide distribution. News articles are also valuable in some instances in passing timely control recommendations to the growers.

During the winter and spring months insect control schools conducted under the auspices of the Farm Bureau reach many growers. At these schools a research or extension specialist leads a discussion on insect problems and answers questions or discusses problems with growers. The annual Truck Gardeners' School for Cook County is held during the middle of February, one entire day being devoted to a discussion of insect and disease control.

Further than simply making available to its growers information regarding insect abundance and giving recommendations for control measures, the Cook County Farm Bureau has during the past two years sponsored a commercial project which makes available a dependable supply of staple insecticides and fungicides, refusing to handle any that have not been thoroughly tested. This enables the entomologist and extension worker to make recommendations with the assurance that insecticides or spray materials are available and encourages growers to take a greater interest in insect control. The materials are sold at the regular retail price, the object of the organization being, not to cut prices, but to render a better spray service whereby the grower might obtain spray materials and reliable information on insect abundance and control recommendations. This project has met with marked success since its inception, receiving the endorsement and support of growers and research workers, and supplying a definite need in the insect control program.

With the present set-up for experimental, field and extension work in northern Illinois, an effective spray service is available to vegetable growers the usefulness of which will be greatly increased as interest in insect and disease control increases.

NOTES ON EXTENSION WORK AT THE VIRGINIA TRUCK EXPERIMENT STATION

By HARRY G. WALKER, *Entomologist*

ABSTRACT

The Norfolk station, organized primarily for research, has always kept close to the growers, and does some incidental extension work in giving general advice, and meeting special needs. As example of the latter, 1932 work on harlequin bug on crucifers and red spider on strawberry was cited. Work is done by cooperation with extension agencies and with insecticide dealers; by use of newspaper articles and radio talks; by field meetings; and by answering calls from individual growers.

The Virginia Truck Experiment Station was established at the request of the members of the Southern Produce Company of Norfolk, a farmers' cooperative marketing organization, and of other growers of truck crops in Eastern Virginia. It was organized primarily for the purpose of conducting research on various phases of truck crop production. Provision was made for the publication of a series of quarterly bulletins dealing with the results of the experimental work conducted by the members of the Station staff. These bulletins are sent to a large mailing list of truck growers and others interested in the production of truck crops.

This Station is located in the very heart of the truck crop area of Virginia. Consequently, the Station keeps in very close touch with the growers and their problems. Growers make frequent calls to the Station to talk over their problems and look over the experimental work at the Station and ask for advice on a wide variety of subjects. In addition, whenever an unusual insect pest appears or some other problem arises which they are not accustomed to handling, a large number of the growers make it a practice to call the Station and ask for someone to come to their farms, diagnose the trouble and prescribe the best methods of control.

Specific examples of this service occurred during the outbreak of the Harlequin bug on various cruciferous crops and of the red spider on strawberries this past season. During the outbreak of the red spider last spring, appointments were made with several farmers to be held at their farms on certain dates and it was recommended that they use finely ground dusting sulphur for the control of this pest. These growers immediately notified their interested neighbors and when we arrived to show them how to apply the dust a large group of men were present at each farm and as far as we were able to determine all of them secured good results by dusting with sulphur.

The first reports of the outbreak of the Harlequin bug were received about August 10th. This pest was seriously injuring early fall cabbage and completely killing young kale in some fields. Examination showed that the insects had been breeding in old seed kale fields and in abandoned fields of other cruciferous crops. The host plants in the seed fields were rapidly drying up and dying and millions of third and fourth instar nymphs were migrating, killing all cruciferous crops as they marched, like chinch bugs migrating from wheat to corn fields in the West. Barriers of creosote and plowed furrows were found to be ineffective in retarding the progress of the nymphs. Therefore, it was recommended that all seriously damaged crops or parts of crops be plowed under, thus destroying thousands of these insects and their breeding grounds. It was also advised that close watch be kept and all remaining nymphs be hand picked or sprayed with a two per cent soap solution as recommended by Fulton.[1] In the meantime, experimental work was started to determine, if possible, a more efficient control than spraying with the soap solution or hand picking. A meeting was held at the Station at which the growers were warned about the seriousness of this pest and urged to take all possible measures to destroy its breeding grounds and thereby prevent further losses from it.

In so far as it is possible, it has been the policy of the Station to try to anticipate the problems which are apt to arise and to send out warnings and advice ahead of time so that the grower may be prepared to meet these problems. This has been done in a number of different ways. The Station keeps in touch with the Extension Division of the Virginia Agricultural Experiment Station, with the County Agents, especially those in the trucking area, and with other State and Federal officials, and cooperates with them in disseminating information to the growers regarding the possible occurrence and the methods of control of various insect pests. In addition, special meetings are often held at the Station and in cooperation with other agencies in various parts of the State where discussions of insect problems are given.

Field meetings are also held showing the results of experimental work conducted for the control of insect pests, and of other projects in connection with truck crop production, including demonstrations of the arrangement of nozzles and the best methods of applying insecticides for the control of different insect pests.

The Station also cooperates with the local insecticide dealers and

[1]Fulton, B. B. The relation of evaporation to the killing efficiency of soap solutions on the Harlequin bug and other insects. Jour. Econ. Ent. 23 (3): 625–630 (1930).

distributors in order that they may be able to give the growers the best service possible in the way of good reliable products for the purposes desired.

In addition to the work with the growers of truck crops, the Station also receives a great many requests from home owners and small home gardeners and from nurserymen and greenhouse men in Norfolk, Portsmouth, Newport News, and the surrounding territory for information on the identification and control of a wide variety of insects, including many household insects such as termites, powderpost beetles, cockroaches, ants, and many garden, fruit, and shade tree insects, and those attacking ornamental plants.

It has long been the custom of the Station to publish, from time to time in the local newspapers popular articles of special interest to the local growers. Recently we have obtained the use of a column in one of the local newspapers in which are published weekly articles of timely interest on various subjects, including entomology.

In addition the Station has arranged, beginning January 15, 1933, to have a fifteen minute broadcast over the radio, each week dealing with subjects of special interest to the home owner and grower of truck crops.

Comments on Vegetable Spray Service

Mr. H. E. Hodgkiss: We have no organized spray service for vegetable crops, but I am very much interested and wish that any one carrying on a definite spray service would report.

Mr. W. E. Blauvelt: New York has a vegetable spray service organized in a few counties which operates on much the same plan as orchard spray service.

Mr. E. N. Cory: I do not see how spray service such as used for orchard insects will work for vegetable insects. We are using mimeographed sheets, news articles, radio and personal calls.

Mr. W. E. Blauvelt: New York vegetable spray service is based on annual pests such as cabbage maggot, cucumber beetles, etc.

Mr. N. F. Howard: I feel that vegetable growers do not make as much noise as fruit growers, but the need for insect control is just as important.

Mr. R. C. Burdette: The difficulty we have is that growers do not appreciate the potential damage from insects and when the damage occurs the farmers plow under the affected crop and plant another in its place.

MR. N. F. HOWARD: I appreciate that such a situation often prevails, but feel this further emphasizes the need for more educational work among the growers.

MR. C. C. HAMILTON: Under the present condition, farmers often discover outbreaks before the research worker. If an extension entomologist were present he could keep in closer touch with insect outbreaks and get the jump on the grower and the insect damage.

ENTOMOLOGY IN 4-H CLUB WORK—AT CAMPS[1]

By GEORGE D. JONES, *Extension Entomology Specialist, Univ. of Missouri*

ABSTRACT

A study of field entomology in 4-H Club camps has been undertaken and found to serve a good purpose. Missouri has been studying different phases of nature study work for the past three years in its 4-H Club camp work. Each club member was to collect ten specimens of insects, mount them properly, and identify them while in camp. It has been gratifying to know that many other states have attempted this type of work in one way or another. The effect of reaching more people is a point that should not be overlooked in this type of work. Training while in camp was undoubtedly worthwhile and the effects and results in the years to follow will be interesting.

The study of field entomology in 4-H Club camps has been undertaken by the Missouri Agricultural Extension Service and found to serve a good purpose, as well as offer something very much worthwhile for each and every boy and girl in attendance. The nature of the work has a very strong appeal to the boy's or girl's interest in life and outdoor things.

Missouri has been using different phases of nature study work for the past three years in its 4-H Club camp work. Forestry was studied during the summer of 1930, entomology the summer of 1931, and weeds the summer of 1932. During the summer of 1931 ten camps were held where the study of entomology was undertaken and 1,115 members took part.

Each club member was to collect ten specimens from a list of twenty-five of the most important insects likely to be found in any part of the state where the camps were held. Cigar boxes were used for mounting boxes. Record sheets were filled in, giving the life habits of each insect. Illustrated material dealing with the twenty-five insects was posted in a convenient place, usually in the laboratory space, where it could be

[1]Contribution from the Department of Entomology, Missouri Agricultural Experiment Station Journal Series No. 349.

used for additional reference and identification purposes. Each club member attending camp prepared at home and brought with him his mounting box, covering the bottom with corrugated paper. Pins, labels, pencils, record sheets, killing jars and butterfly nets were furnished and taken to each camp by the club agents. Motion pictures of the development of the Monarch butterfly, the mosquito, and a wild west story were used as a night program for one of the evenings.

The boys and girls were divided into two large divisions to receive instructions. There were three one-hour instruction periods each day for the entire camp. The work was so organized that while one of the divisions was with the State Club agents, the other was collecting in the field and would return the next hour and work in the laboratory. Such a division of labor necessitated three one-hour periods of instruction with each alternating and doing the same work at different periods. Each large group was divided into groups of five for field work. Each five were given a killing jar and a net. The killing jar was a pint fruit jar with a clamp lid. Calcium cyanide was used for the killing agency in the jars. Insects were collected, brought in in the killing jars, pinned, studied, and mounted in the cigar boxes in the laboratory. This required considerable thought and individual initiative. Specimens had to be compared, identified properly, and labeled. It was surprising to note the speed some of the club members showed in grasping the method of procedure. County agents and project leaders assisted with the laboratory work and soon became very proficient in the identification of the common insects. Many of the county agents commented after the camp broke up by saying that the work helped them greatly, as much almost as the boys and girls. Prizes and ribbons were offered to those who did the best work. This stimulated interest and caused them to work harder.

It has been gratifying to know that many other states have attempted this type of work in one form or another this past summer. The results they have had will be interesting. Was it worthwhile? Missouri thinks so and within the next year or so will plan such a study again. T. T. Martin, the State 4-H Club Leader, seems anxious to give it again. He feels that it fits into his 4-H Club project fine and offers the boys and girls something that is both recreational and instructive.

Many of the boys and girls who had the work last year have commented to the writer personally that it helped them understand the why of insect control. Most farm boys and girls are eager to study an everyday happening of life, especially if it has an influence on their work. Many have found oftentimes that the limiting factor in their

project work hinges on some insect control measure. They soon learn from their parents perhaps that things have to be planted and handled in such a way, but when they see the small insect pest or understand how a closely related species develops they have a better understanding of control measures and they appreciate the reason why a certain outline of procedure or recommendation is given. They can be intelligent about a pest and its control. It seems to me that a study of this sort will do much toward causing people to recognize the importance of insect control, as well as appreciate the interesting and the nature study side of the field of entomology. It should pave the way for 4-H Club insect control projects. There seems to be much in this field untouched as yet.

The effect of reaching more people is a point that should not be overlooked in this type of work. The attendance at the ten camps totaled 1,115 boys and girls, leaders, county agents, and home demonstration agents from some forty counties. Many visitors came for the evening program and picture show and were at the camp at different times during the progress of the work. Approximately one thousand and seventy-five individuals were made acquainted and introduced to entomology for the first time. A great number had vague ideas about what the field of entomology covered and many learned for the first time how insects live and multiply. Again, it would be hard to count the number who benefited by the work for every boy and girl took home with him many interesting experiences, as well as some knowledge of a new truth or idea they had grasped. Many of the parents, no doubt, found themselves interested more in the subject than ever before. In a few more years these boys and girls will be taking over the farms or entering business in one way or another and perhaps a few might enter the field of entomology but, regardless of what they do, the training will have been beneficial because insects do not seem to be partial to any particular vocation when it comes to man's ownership of material things. It will be interesting to watch the effect of this type of work as it is more and more developed.

4-H CLUB WORK AND ENTOMOLOGY

By C. O. HOPKINS, *Baton Rouge, La.*

ABSTRACT

Prior to 1932 all 4-H Club work in entomology was confined to club camps. Last year by using 4-H Club lessons on entomology prepared by the Extension Entomologist, County Agents were able to reach a larger number of their club members with insect control information.

Prior to 1932 4-H club work in Extension Entomology was limited to two or three weeks activity at the summer 4-H club camps where classes on insects and insect control, were conducted. At these camps from 300 to 500 club members were reached. This method was unsatisfactory when the 18,000 club members in the state were considered.

Along with the closer cooperation of the county agents and the parish school officials, came an agreement whereby the 4-H club meetings were to be held on a definite schedule at which time the county agents were to present subjects which they considered worthwhile and timely.

The results of these arrangements together with a ruling of the Director of Extension, stating that the primary duties of the specialists were to train county agents and furnish them the latest information in order that they might be prepared to present worthwhile subject matter at these meetings, were requests from the county agents, to the state Club Leader, for method demonstration outlines adapted to the 4-H club meeting.

Entomological subject matter is admirably adapted to method demonstrations hence a number of demonstration lessons were prepared and submitted to the State Club Leader, Mr. W. C. Abbott, for approval. Outlines on: Garden Insect Control, Fumigation of Rooms and Houses, Stored Grain Fumigation, Peach Tree Borer Control, Scale Insect Control, Clothes Moth Control, Preparation and Use of Ant Poison, and several other lessons were included.

The outlines were modeled after those in the high school laboratory manuals used by biology and chemistry teachers. It was thought that in this form much confusion could be prevented and the lessons demonstrated more clearly.

In preparing each lesson Farmers' Bulletins or Extension Circulars were used as reference. This enabled the county agent to have full reference at hand without cost and to pass out bulletins as he saw fit. Questions were prepared and spaced on the back of each outline so a written answer could be given by each club member, thus enabling the agent to check up on the efficiency of the presentation if he cared to.

They were never more than one page long and the outline followed was the same in every lesson.

The outline: 1. Name of Lesson; 2. Summary paragraph; 3. Object; 4. Material; 5. Procedure; 6. Reference.

With Mr. G. L. Burleson, then assistant club leader, the Extension

FIG. 52—Dusting kit used in garden insect control demonstration.

Entomologist visited twelve 4-H clubs in four parishes to present these lessons and observe the response of the club members to this type of meeting.

The Garden Insect Control demonstration, then a timely topic, was given. The presentation was made as simple and practical as possible. The kit shown in the accompanying photograph was used in the demonstration. (Fig. 52).

This kit consisted of a small plunger type dust gun designed to fit a screw top fruit jar. The jar then served as a dust container once the gun was attached. Five quart jars containing nicotine dust, pyrethrum powder, sulfur, bordeaux dust, and barium fluosilicate made up the remainder of the kit. On each jar the label was self explanatory. As: nicotine dust for sucking insects, or barium fluosilicate for chewing insects.

Approximately 700 club members were reached in four days to say nothing of the biology and vocational agricultural students who attended.

Measuring the results of the 4-H club meetings could not be done. The attention given by the members, their correct answers to the questions asked, and the enthusiasm expressed by the school teachers

and the county agents led us to believe the type of instructions were very satisfactory.

Results of a series of method demonstration—leader training meetings in sixteen parishes this spring, using the same lesson and pest kit, were very satisfactory and gave us a means of checking the efficiency of this type of teaching.

In each parish the home demonstration agent called a council meeting. It was attended by two leaders from each community. The demonstration was given and the leaders were taught to repeat the demonstration. With the assistance of the home demonstration agent these leaders gave the demonstration in their respective communities.

Results of these meetings turned in to the garden specialist shows 458 garden club members using insect control for the first time and 175 pest kits prepared.

By charging $31.00 per meeting for the total cost of the specialists and home demonstration agents time, we found that we were able to train a leader for $2.02 and that each practice adopted this year as a direct result of these meetings cost $1.09.

CONCLUSIONS. The work has not progressed far enough for any definite conclusions to be drawn. Although there are many wrinkles to be ironed out, we are convinced that it is a decided improvement over our first methods, in so far as reaching greater numbers of club members are concerned. We know that such a method as just described fits well into our organization and indications are that the principles used in this set-up will be the same in any future system adopted.

J. J. DAVIS: I am glad this subject was included on the program. We all have a wonderful opportunity to stimulate interest in insect study by methods suggested in the papers just presented and we have ample evidence that the influence goes further than to the youngsters, who will be our active constituents a few years hence, for they carry our messages to their parents and the influence benefits the science of entomology in various ways.

In Indiana, we have for the past eight years given insect study work in two or more 4-H Club Camps nearly every year. We have not attempted to have the boys and girls make insect collections for our camps last but three days and we feel that we can secure greater returns by utilizing the short time in other ways. On the first day of the camp we give the boys and girls a general understanding of insect life and an inspiration to learn more about these dominant animals, using for this purpose illustrations, cabinet specimens and live insects. The

second and third days we utilize for field trips and here they see many kinds and stages of insects and the injury they do, and at the same time learn the first principles of observation.

For the past eight years we have also held an insect collection contest at the annual 4-H Club Round Up. This contest has aroused much interest, not only among the boys and girls entering the contest but also from those who see the collections in the exhibit rooms. The last four years we have added an insect identification contest which has been unusually popular, due in part to the fact that the difficulties of bringing a collection from distant points are not present.

At the present time there is a movement among the State Academies of Science to develop Junior Academies or Science Clubs. Already a number of states have organized such clubs and the movement will likely spread to practically every state. Here is another place where the entomologist can foster and aid young naturalists and add prestige to the science of entomology.

The contacts with the young people by these methods are not intended to make entomologists out of them but to develop in the minds of those who will make up the future generations an appreciation of insect study as a science and as it relates to the well-being of every human individual.

SUMMARY OF THE REMARKS BY E. N. CORY

Due to the necessity for adequate local supplies of insecticides and machinery and the fact that the average dealer is uninformed as to the merits of various insecticides and are therefore at the mercy of high-powered salesmanship, most dealers look to their County Agricultural Agents for advice with regard to insecticides that they should stock, particularly in the case of a general outbreak such as that of the Mexican bean beetle. The advice of the County Agent in turn must necessarily be predicated upon the information that he receives from headquarters, particularly in the case of insecticides from the office of the entomologist.

Two factors enter into the advice that the entomologist must give to the County Agents and to dealers directly, namely confidence in the manufacturer and knowledge of the performance of the insecticides gained by field tests. Fortunately it has been our experience that we can place confidence in the integrity and sincerity of most of the insecticide dealers. They are seeking constantly to improve their products and to this end cooperate splendidly with all agencies that are seeking to establish by testing the value of the products they offer. The testing

of insecticides is an important part of the activities of any entomologist, particularly when such pests as the Mexican bean beetle appear. In such a case there are some worthwhile compounds offered for control and in the face of this fact it seems rather futile to include such things as Epsom salts in a series of tests, but the ineffectiveness of any insecticide must be established as well as the relative effectiveness of materials and mixtures that might offer reasonable promise of being effective.

In 1929 during the outbreak of the Mexican bean beetle this method was followed most successfully. The relative efficiency of the long series of insecticides tested by Messrs. Sanders and Langford and the results were used very largely as a guide by all dealers in the state in stocking insecticides to meet the outbreak, with the result that there was very little waste of effort and money by the commercial producers of beans either for canning or market. A similar situation with regard to orchard machinery and methods, though based on a somewhat longer time of testing and experience, exists.

On the whole, we believe that there is a mutual confidence established between dealers in machinery and insecticides and the Department of Entomology that works out very satisfactorily and to the advantage of all parties concerned, especially the ultimate users of the insecticides

A COURSE IN INSECTICIDES FOR PHARMACISTS

By J. J. DAVIS, *Purdue University, Agricultural Experiment Station*

ABSTRACT

A course in insecticides for pharmacy students offered by Purdue University, and other efforts of the university to promote availability of insecticides and better understanding of their use by dealers, are described. It is believed this will be a valuable aid to better insect control.

Availability of recommended insecticides is probably as great a need in economic entomology as are methods of insect control. Another important need in every community is a dealer who not only carries recommended materials, but also one who has a general understanding of the fundamentals of insect control. Among dealers in insecticides, the pharmacist is becoming an increasingly important factor. Realizing this fact and that the pharmacist has an unusual opportunity to develop an insecticide trade and profit thereby, the School of Pharmacy of Purdue University requested that the Entomology Department offer a course in Pharmical Entomology or Entomology for the Pharmacist

to the students specializing in Pharmacy. This course[1] was offered for the first time in the fall of 1931 with 27 students. It will be continued hereafter as a regular course in the curriculum of the School of Pharmacy.

We believe this is an important development in insect control and that other schools of pharmacy may well follow this example in preparing men and women for the profession of pharmacy, for certainly, with the hundreds of trade-named insecticides on the market, it is well, at least from the entomologists' point of view, that the druggist understand the preparations he is selling and that he be able to prescribe or fill prescriptions suggested by the entomologist just as he fills prescriptions of the physician. Furthermore, he has a wonderful opportunity to develop a trade which will be profitable and at the same time decidedly beneficial to his community. The need of trained men or at least men who have an appreciation and a general understanding of insect control to dispense insecticides becomes increasingly important with the advent of hundreds of trade-named materials, so many of which are worthless or are sold under trade names at exhorbitant prices.

In connection with the course set up for pharmacy students, the Department of Entomology of Purdue University with the generous cooperation and aid of insecticide manufacturers, has developed an excellent exhibit of chemical and trade-named insecticides.

Furthermore, realizing the need of a guide for dealers in insecticides, which includes all pharmacists, the Purdue School of Pharmacy financed the publication of a bulletin on Insecticides and Their Uses.[2]

The School of Pharmacy has an extension specialist who maintains a close contact with the pharmacists and through this contact as well as through meetings of sectional or state organizations, the entomologist is able to inform the dealers of new developments in insect control and advise on the materials which should be kept in stock.

We feel that this entire set up of aiding the potential as well as the present dealers in insecticides will be a material aid in insect control and enable the dealer to build up a more profitable trade and at the same time eliminate a great deal of loss to the consumer by providing a source of reliable and recommended materials and minimize the sale of worthless or exhorbitantly priced insecticides.

The needs of the dealer in insecticides include a knowledge of insects and their control, sources of information on insect control, insecticides to be kept in stock, an understanding of chemical insecticides and how

[1]An outline of the course will be provided to those interested.

[2]Bulletin of Purdue University, vol. 32, No. 7, March 1932, Pharmacy Extension Series No. 1.

to recognize reliable trade-named materials. Manufacturers should realize that state and federal entomologists cannot recommend trade named materials and should wherever possible put out insecticides under chemical names and depend on the brand name to support their product. The Food and Drug Administration should give more attention to the labeling of insecticides. The entomologist should maintain a closer contact with the dealer and aid him whenever possible because such aid will be a great benefit to the ultimate consumer.

DIRECTORY OF MANUFACTURERS OF INSECTICIDES, THEIR PRODUCTS AND ANALYSES[1]

By THOMAS J. HEADLEE, Ph.D., *Entomologist, New Jersey Agricultural Experiment Stations*

ABSTRACT

The large number of new insecticides yearly offered for sale, many apparently untried, and the desirability of distinguishing between meritorious and untested products, were discussed. The possibility of a license system was considered. It was urged that the federal insecticide and fungicide board publish findings.

The economic entomologist is today, more than ever before, constantly beset with requests for information on the efficiency of this new spray and that new dust for use against insects which attack man himself, and his plant and animal crops. This condition obtains because the people in general, and the plant and animal growers in particular, are offered every year a large number of apparently new chemical compounds for which great and attractive claims are made. High powered salesmanship is employed by manufacturers and a considerable quantity is disposed of to the ultimate consumer. If the compound works out satisfactorily in the hands of the consumer, the sales effort is redoubled and a new insecticide business is launched. If, on the other hand, the compound in the hands of the consumer is a flop, the formula is changed and the same effort begins anew.

It does not seem reasonable that any considerable proportion of large and apparently new insecticides appearing each year can have any considerable fundamental research back of them. It looks as if chemists have concocted them as possibilities and concerns are distributing them to consumers for testing. The consumer first buys the product, second applies it, and third reaps the benefit or absorbs the

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

loss. Recovery of damages for these losses is exceedingly difficult to secure.

Of course, there are many insecticide concerns that go to great expense and use much time in concocting an insecticide, in exploring the field for its use and in learning its limitations, before it is ever offered to the public. Such procedure is most commendable and should be sound business policy. Nevertheless, this carefully developed and tested product must be sold in competition with similar products brought out overnight with a fractional production expense.

It would seem that there should be some means of giving the concern, taking all this care and trouble, an advantage in this competition. Perhaps, the fact that the product thus carefully prepared will eventually win the confidence of the consumer is in itself sufficient advantage. If not, some form of adequate licensing scheme would have to be developed.

Any really effective licensing scheme would involve a rather fundamental knowledge of insect parasite and host toxication. Of course, the number of known chemical agents for destroying insect parasites without injury to hosts and host materials are limited. Compounds including chemical agents concerning the toxic action of which there is only inadequate information or no information would have to be refused license.

At the outset of this paper the writer pointed out that the economic entomologist is constantly beset by inquiries about the efficiency of each year's crop of apparently new insecticides. Unless he does nothing else and has a large staff he is left hopelessly behind in any effort to test these insecticides.

About the only thing he can do is to secure from the manufacturer's guarantee the nature of the active principle as its appears in his registration, base his judgment upon the known toxication of this active principle, and answer the inquiry accordingly. Sometimes the nature of the toxic principle is not revealed by the registration record. Sometimes the active agent proves to be a material concerning which there are no toxication records.

These facts reveal that the present insecticide market is in a chaotic condition from the standpoint of manufacture and use of insecticides. The immediate need is regularly secured and regularly published information on the performance of this increasing flow of compounds as they come along. The final solution appears to rest in regulation through licensing manufacturers. A well-considered practice of meeting

the immediate need will furnish the basic information for putting the final solution into operation.

Many years ago, when the proposition of the insecticide and fungicide board was under consideration, many of us thought that this proposed federal agency would furnish a constant supply of information on the volume of new insecticides. As a matter of fact this board does test many of these new insecticides as they appear on the market in interstate commerce. These compounds are tested, apparently solely from the standpoint of misbranding, and eventually the nature and results of subsequent court action are published.

The court action records furnish very unsatisfactory information for the working entomologist. Yet it is obvious that many new and important facts concerning the insecticidal efficiency must be disclosed in the course of this testing.

For some reason this board has refrained from publishing its results. I have been given to understand that this is a matter of policy but have never heard any good reason for this policy.

Thus the sole agency, which might meet this need of the working entomologist, is either unwilling or unable to function.

I am not and, I imagine, many others are not as interested in a directory of manufacturers as we are interested in the quality and performance of their products.

In these days, when chemical control is so strongly emphasized, why can not the sole agency engaged exclusively in testing insecticides and fungicides give us the advantage of the data which it gathers? Perhaps if we knew the obstacle in the way we could do something to remove it.

May I suggest that a special committee should be appointed to look into this matter and be empowered to do and perform all things practicable to the end that such information be made available for general use?

INSECT PESTS

By J. A. HYSLOP, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The insect conditions of 1932 were discussed, with a consideration of weather effects, especially of the preceding mild winter. A number of the principal pests were discussed, notably the grasshoppers in the northern plains, and the increase of several pests on the northern edge of their normal range.

The abnormally mild temperatures that prevailed during the winter of 1931–32 over the greater part of the Eastern and Southern States, followed by severe freezing in March, were probably responsible for many unusual insect developments.

The grasshopper infestation in the Great Plains was more widespread than it was in 1931 but, in general, less severe. Rainy, cool weather in May and June in the southern part of this area resulted in a rank growth of wild vegetation, which reduced the damage to cultivated crops. This weather was unfavorable to the development of young hoppers, and later parasitic flies, and sometimes a fungus disease, further reduced the grasshoppers. The most seriously infested areas this year were eastern North Dakota, central South Dakota, northwestern Minnesota, and to a lesser extent northern Wisconsin, and northern Michigan. Another section of somewhat severe damage was reported from north central Nebraska. In the Gulf region and along the south Atlantic seaboard the American grasshopper (*Schistocerca americana* Drury) became unusually abundant late in the season.

The European corn borer did not spread so far as usual this year. Newly infested townships in Indiana, Maryland, Kentucky, Pennsylvania, and Virginia, however, were found this fall. The corn borer is now known to infest portions of the New England, Middle Atlantic, and East Central States, westward to Wisconsin and Indiana, and southward to Kentucky, West Virginia, and the eastern shores of Maryland and Virginia, and the eastern corn-growing provinces of Canada.

The Hessian fly passed the winter with but little mortality over the greater part of the winter wheat belt. Very cold weather during the middle of March, however, was disastrous to the pupae in the eastern part of this area. From Illinois westward a very high percentage survived and, during the spring, heavier infestations occurred throughout this belt than had been recorded in several years.

The chinch bug was troublesome much farther north and east than is usually the case. Reports of damage were received from Pennsylvania,

eastern Ohio, Michigan, Wisconsin, southern Minnesota, and Nebraska, in addition to the normal chinch bug territory which extends from eastern Kansas into northwestern Ohio. It appears that this insect is entering hibernating quarters in larger numbers than it has for several years.

During May the alfalfa weevil was found well established in the San Joaquin Valley in California, in which state this insect was only previously recorded from a few isolated localities, from Lassen to Mono Counties along its eastern border.

The green bug developed in threatening numbers during the late winter in the South Atlantic States and Gulf region. This, however, did not develop into a serious outbreak, although local outbreaks were reported from west-central Missouri, northwestern Mississippi, and south-central Pennsylvania.

The codling moth survived the winter very successfully. As the season advanced it was reported as being very numerous throughout the greater part of the country. In Illinois it was more injurious than it has been any time during the past 10 years. Cool weather during June materially retarded the infestation in western Washington, but later the infestation was heavier than usual in that State.

The San Jose scale continued to increase from the North Atlantic States westward to Illinois, Michigan, and Missouri.

The plum curculio emerged from hibernation in the southern part of the Atlantic seaboard later than it had in many years. Early in the season it was but moderately abundant over the East Central States, and somewhat more abundant than usual from Kentucky to Mississippi. It apparently went into winter quarters this year in greater numbers than it did in 1931.

The oriental fruit moth emerged late this spring. In the East Central States it seems to be increasing in numbers and for the first time was recorded as generally distributed over northwestern Arkansas and eastern Kansas. With the short crop of peaches that matured over the upper part of the southeastern peach belt, the damage was much more serious than would normally have been the case.

The Japanese beetle was discovered this year at several points outside of the previously regulated area. Among these were two points in Maine, six in New Hampshire, three in Vermont, three in Ohio, one in Michigan, three in West Virginia, three in North Carolina, and one in South Carolina.

The vegetable weevil continued to spread northward and eastward during the year. It was found to be infesting the entire northwestern

quarter of Louisiana and the southeastern corner of Arkansas, and, in addition to the territory already known to be infested, to occur well over the western border of Georgia. It was also found in one county farther west in Texas.

The Mexican bean beetle did not very materially advance its known range. It was, however, found for the first time in the States of New Hampshire, Maine, and Illinois, and has moved somewhat farther northward in Vermont.

The harlequin bug was reported as destructive in Maryland, West Virginia, and southeastern Iowa, which points are considerably north of the normal range of this pest.

The banded cucumber beetle was decidedly on the increase in the eastern part of its range, having been reported as troublesome not only in the Gulf region but in South Carolina, Florida, and Georgia.

The boll weevil passed the winter over most of the Cotton Belt in greater numbers than it has in the past seventeen years. Very heavy damage to the early crop occurred throughout the South with the important exception of western Oklahoma and western Texas.

The pink boll worm was discovered this spring in southern Florida and in the autumn a very light infestation was found at three points in northern Florida. This is the first time this insect has been found in the eastern part of the Cotton Belt.

The elm leaf beetle appeared in destructive numbers at many points throughout the Middle Atlantic, New England, and Central States, and there were isolated outbreaks in Kansas and along the Pacific Coast.

The gladiolus thrips was quite destructive to gladiolus at many points throughout the Atlantic States westward to Tennessee, Illinois, and Minnesota.

An unpredecented outbreak of screw worms was reported during October in the Yazoo-Mississippi Delta in Mississippi, occasioning losses in the livestock business of that section.

Forty-one cases of Rocky Mountain spotted fever were reported from the States of Maryland and Virginia up to the middle of August of this year. Heretofore this dread disease of man borne by a tick was known only from the northern Rocky Mountain region.

THE ADVANTAGES OF CONCENTRATING STATE ENTOMOLOGICAL WORK, WITH SPECIAL REFERENCE TO THE REGULATORY AND EXTENSION PHASES

By CLAY LYLE, *Entomologist, State College, Mississippi*

ABSTRACT

The performance of both regulatory and extension phases of entomology and plant pathology by inspectors of the State Plant Board of Mississippi has been satisfactory. The concentration of all entomological activity in one office has resulted in efficiency and economy and prevented duplication and friction.

While serving primarily as a regulatory organization and discharging such duties as nursery inspection, sweet potato inspection, apiary inspection, quarantine enforcement, and others of this nature, the State Plant Board of Mississippi has found it practical and advisable in the control and eradication of various pests to give assistance of a type which might be classed as extension work. As the state has no official extension entomologist, the demands upon Plant Board inspectors for information and assistance have been all the greater.

In visiting thousands of sweet potato growers, Plant Board inspectors are each day asked for control measures for various field, orchard, garden, and household pests. The owners of the hundreds of nurseries at all times expect the inspectors to advise the best control for nursery and greenhouse enemies. Beekeepers expect apiary inspectors to advise them of the best apiary methods and practices. Thousands of others who do not have regulatory contacts with the inspectors call upon them for pest control information and assistance. The inspectors are stationed at fourteen points in the state at present (twenty to twenty-five before the depression), each in charge of a district varying in size according to the amount of work to be done. They are all college graduates with special training and experience in entomology and plant pathology, and in order for the state to secure the greatest possible benefit from them, their work should not be limited or circumscribed by a narrow interpretation of their duties. Although these inspectors have no official extension status, every effort is made to work in close cooperation and harmony with the Extension Department, and several of the inspectors have had offices with the extension farm agents of the counties in which they maintained headquarters. In no sense has the performance of its regulatory or police duties resulted in embarrassing or hindering the Plant Board in its other lines of service to the people.

In addition to the economy and efficiency of the full utilization of

the training and experience of the inspectors by this combination of their duties, several other advantages result from the concentration in one office of the direction of all entomological work in the state. The Entomologist and Executive Officer of the State Plant Board is also the Entomologist of the Experiment Station and Head of the Department of Entomology of Mississippi State College. Farmers orchardists, and truck growers out in the state are not bothered by trying to keep in mind the functions of several related organizations, but regardless of whether they address their complaints or packages of specimens to the State Entomologist, State Plant Board, Experiment Station Entomologist, Professor of Entomology, or merely "Bug Department," they are all received in the same office and handled without any delay, confusion, or friction. One office being responsible for all entomological work avoids the confusion which sometimes results from conflicting recommendations or statements by the different agencies concerned. This system also prevents any duplication of work or friction which might arise from different interpretations or opinions of the duties of the several organizations.

Among other advantages, this concentration results in the keeping of better insect records, the better utilization of insect collections, more economy in office and laboratory space and equipment, a better entomological library and teaching facilities, and a larger staff of workers than would be possible if the limited funds available had to be divided among three or four separate organizations, each with its offices, equipment, and personnel entirely distinct from the others. This unified system has worked well in Mississippi for the past fourteen years, and apparently has been equally satisfactory in the other states where it has been tried.

BIOLOGY AND CONTROL OF *CHRYSOMPHALUS DICTYOSPERMI* (MORG.)

By A. W. CRESSMAN, *Associate Entomologist, Division of Fruit and Shade Tree Insects, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The biology and control of *Chrysomphalus dictyospermi* (Morg.) is discussed. This coccid attacks certain greenhouse and ornamental plants and tropical and subtropical fruit and shade trees. Data are given on reproduction, development, mortality, natural enemies and host susceptibility. Oil sprays have proved to be an efficient means of control.

Previous to the winter of 1923–24, *Chrysomphalus dictyospermi* (Morg.) was one of the most serious of the scale-insect pests of New Orleans. In sheltered places the insect survived the freeze of that winter, and there has been a gradual increase in its numbers in recent years, although the infestation is not yet as general as formerly. In Florida Moznette (7) reported this coccid as the most destructive pest of avocados, and more recently the scale has been reported as infesting avocado plantings at Whittier, Calif. (12).

Starting in 1923, biological studies of this scale, later supplemented by weekly seasonal counts, were conducted in New Orleans. The gradual increase in the scale in the New Orleans district and its menace to avocados in Florida and California have made it advisable to publish the results of these investigations.

METHODS.—Experiments were carried on in a partly closed insectary, the insects being protected from direct sunlight and rain. Scales were reared on the following hosts: Satsuma orange (*Citrus nobilis unshiu*), latania (*Latania commersoni*), sago cycas (*Cycas revoluta*), and camphor-tree (*Cinnamomum camphora*). Infestations on each of these plant species as well as on the climbing fig (*Ficus pumila*) supplied rearing material. The scales were scraped from the infested leaves on to a piece of paper, and the active crawlers transferred with a camel's-hair brush to the new host plant. Insectary temperatures were recorded by a thermograph checked daily against maximum and minimum thermometers. Daily mean temperatures were calculated from planimeter readings.

DESCRIPTION OF STAGES AND VARIETAL DIFFERENCES.—All stages of the insect itself showed a lemon-yellow color, but the appearance of the covering varied considerably, a variation that was in part dependent on age. The cover of the immature scales was yellow brown to brown, and semitransparent outside of the exuviae. The older scales showed all gradations from gray to dark brown; in some scales the first exuvia was depressed, in others it formed a nipple-like prominence.

Several varieties of this species have been described—*pinnulifera* (Mask.) (6, p. 208), *arecae* (Newst.) (8, pp. 185–186), *jamaicensis* (Ckll.) (3, pp. 128–129), and *minor* (Berl. and Leon.) (1, pp. 346–347). All of these varieties have been based on differences in the appearance of the covering, and in view of the fact that we have observed just such differences in single infestations with no corresponding morphological and biological differences in the insect, these variations in the cover must be considered of doubtful validity as criteria of varietal differences. However, that markedly different strains of this scale do exist is indicated by reported differences in the sexual and reproductive habits.

Moznette (7) states that in southern Florida the insect appears to be parthenogenetic. According to Britton (2, p. 15) the scales in Connecticut are parthenogenetic, bring forth living young, and the males are unknown. In the New Orleans district all the scales studied were oviparous and fertilization was necessary for reproduction.

The Coccidae show great variation in their reproductive habits. Thomsen (10, pp. 3–46) in studies of *Saissetia*[1] *hemisphaerica* (Targ.) and *Coccus*[1] *hesperidum* L. has found two races in both of these species, one always parthenogenetic and one facultatively parthenogenetic. Gabritchevsky (4) working with *Aspidiotus hederae* (Vall.), found both bisexual and parthenogenetic cultures, while Schrader (9) has studied one race of *A. hederae* and found it always parthenogenetic. He suggests that races similar to those in Lecanium may exist, and that Gabritchevsky may have had a population composed of both strains. It is possible that similar conditions may exist with *Chrysomphalus dictyospermi*, with the difference that in some strains females require fertilization for reproduction instead of showing facultative parthenogenesis. Since hermaphroditism has been shown by Hughes-Schrader (5) to be the usual method of reproduction in one coccid, *Icerya purchasi* Mask., cytological investigations would be necessary to determine definitely the type of reproduction in the colonies on which the Connecticut and Florida reports were based.

Eggs and Crawlers.—In the writer's experiments the eggs were deposited and hatched beneath the scale covering. A range in the length of the incubation period of from 1 to 24 hours in midsummer has been observed, indicating that this insect, in common with many other coccids, deposits the eggs at various stages of development. The "crawler" was positively phototropic and negatively geotropic. Records taken at hourly intervals showed a marked diurnal periodicity in the time of emergence of "crawlers" from beneath the parent scale, as may be seen in the following summary:

Hour removed	*Number emerged and removed*
8 a. m.	235
9 a. m.	4,090
10 a. m.	2,390
11 a. m.	820
12 noon	307
1 p. m.	70
2 p. m.	30
3 p. m.	20
4 p. m.	4

[1]Lecanium of Thomsen.

No nymphs were found before 7 a.m., by 8 o'clock a few had emerged, while the peak of the emergence came between 8 and 9 a.m. That this periodicity was not directly a function of temperature within the range studied can be shown by a comparison of the emergence and temperature up to 9 a.m. for the different broods. (Table 1.)

No crawlers emerged before 8 a.m. during September, 1925, although temperatures as high as 28.3° C. (82.9° F.) were recorded, whereas in April, 1924, 3.6 per cent of the total came out from the covering, with no temperatures higher than 23.3° C. (73.9° F.). In each case the peak came during the 8 to 9 o'clock interval, yet at the time of the April brood the hourly temperatures did not average above 25.8° C. (78.4° F.) until 11 a.m. This was the minimum 8 a.m. average for the other three broods.

The time between emergence and settling ranged from less than 1 hour to 24 hours, and once the beak was inserted the scale did not move. The streaks of dead tissue sometimes observed, and which, in the case of *Chrysomphalus aonidum* L., have been erroneously ascribed to the scale moving and pulling the beak through the leaves, probably mark the position of the long beak. The positions of the scales were marked immediately after they settled, in numerous cases, and no scales were ever found to move, although the leaves usually showed these characteristic threads of dead tissue.

Duration of Instars.—The female undergoes two molts, after which she is ready for fertilization. The length of the instars was determined from the date that the majority on each plant molted, and this period was then correlated with the mean temperature. No difference in the lengths of the respective instars was found on the four different hosts. The time required for the first instar in both sexes, for the second instar in the females, and for the period from the second molt of the females to the emergence of the first crawlers has been plotted in Figure 53 as a function of temperature. The effect of thermal change was most marked in the lower range, the acceleration decreasing at higher temperatures. In every case the first instar was shorter than the second at equivalent temperatures.

The life history of the male following the first molt was quite different from that of the female Both the insect and the covering elongated during the second instar and feeding ceased after the second molt. After the fourth molt the male became a winged adult and emerged from the covering. Table 2 gives the approximate lengths of the second, third, and fourth instars and of the adult stage up to emergence.

At all temperatures the females had completed the second molt before

TABLE 1. COMPARISON OF EMERGENCE OF CRAWLERS OF *Chrysomphalus dictyospermi* UP TO 9 A.M. FROM FEMALES OF DIFFERENT BROODS

Date of experiment	Per cent of daily emergence		Temperature							
	Before 8 a.m.	8 to 9 a.m.	8 a.m.				9 a.m.			
			Range		Average		Range		Average	
			°C.	°F.	°C.	°F.	°C.	°F	°C.	°F.
Aug. 28 to Sept. 6, 1923	5.0	76.5	25.3–28.6	77.5–83.5	26.2	79.2	27.2–29.1	81.0–84.4	27.8	82.0
Apr. 14 to 23, 1925	3.7	42.4	17.2–23.3	63.0–73.9	21.0	69.8	20.5–25.3	68.9–77.5	23.5	74.3
July 29 to Aug. 7, 1925	3.6	57.7	23.3–27.8	73.9–82.0	25.8	78.4	25.0–30.0	77.0–86.0	27.7	81.9
Sept. 16 to 25, 1925	0.0	56.5	23.9–28.3	75.0–82.9	26.6	79.9	27.8–29.4	82.0–84.9	28.4	83.1

the males had emerged, but since all stages are present at one time, this does not appear to be of any importance in insuring fertilization

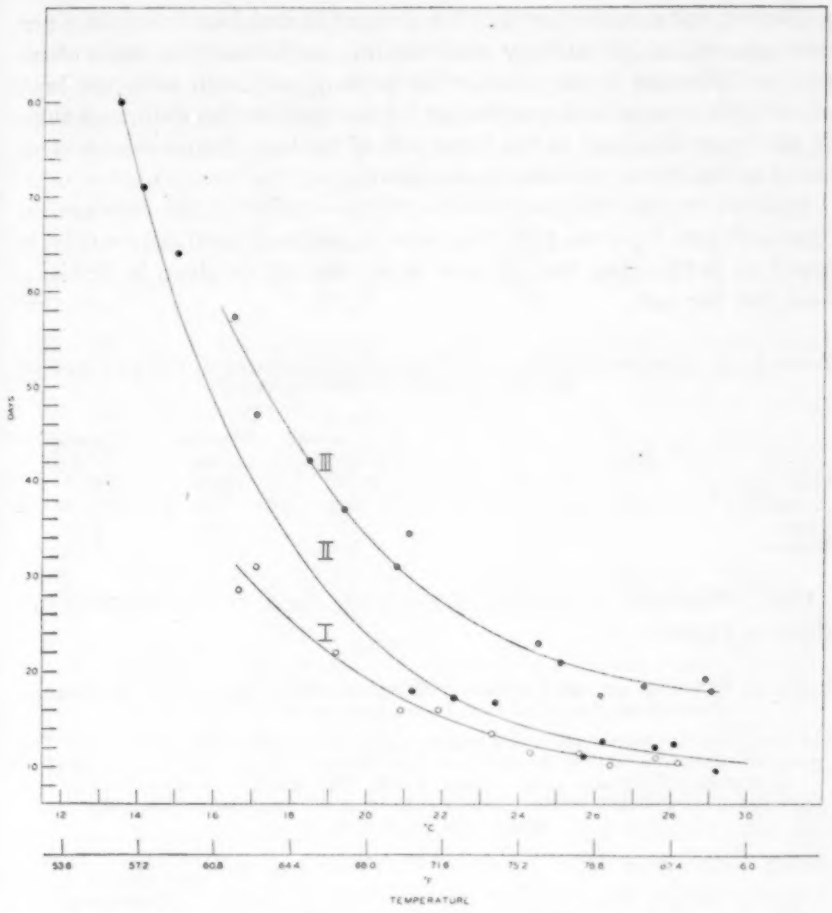

FIG. 53.—Relation between temperature and length of developmental stages of *Chrysomphalus dictyospermi* (Morg.). Curve I represents the first instar of both sexes; II, the second instar in the females; and III, the period from completion of the second molt in the females to emergence of young.

TABLE 2. APPROXIMATE LENGTH OF INSTARS OF MALE *Chrysomphalus dictyospermi*

Second instar			Third instar			Fourth instar			Adult (to emergence)		
Days	Mean temp.		Days	Mean temp.		Days	Mean temp.		Days	Mean temp.	
	°C.	°F.		°C.	°F.		°C.	°F.		°C.	°F.
74	13	55.4	6	19	66.2	10	15	59	4	21	69.8
15	22	71.6	3	23	73.4	4	23	73.4	3	24	75.2
11	28	82.4	1	25–28	77–82.4	3	27–28	80.6–82.4	3	27–28	80.6–82.4

of the females. The same relation in the length of the life cycle of the two sexes has been observed in *Pseudaonidia duplex* (Ckll.) and *Chrysomphalus aonidum* (L.).

The sex was recorded for 2,219 scales and it was found that 54.8 per cent were males and 45.2 per cent females. As between the sexes there was no difference in the position of settling, although with the host plants studied more scales settled on the leaf than on the stem, and more on the upper side than on the lower side of the leaf. Scales were seldom found on the lower surface of palm leaves.

MORTALITY AND PRODUCTIVITY.—The mortality of the crawlers on different hosts from the time they were transferred until they settled is found by subtracting the per cent which settled, as given in Table 3, from 100 per cent.

TABLE 3. SETTLING OF CRAWLERS OF *Chrysomphalus dictyospermi* TRANSFERRED BY BRUSH TO INDICATED HOST PLANTS

Host	Number of crawlers transferred	Number settled	Per cent settled
Latania	2,360	1,819	77.1
Camphor	959	714	74.5
Cycas	507	293	57.8
Satsuma	1,492	1,077	72.2

The percentages of survival of the later stages in the insectary are given in Table 4.

TABLE 4. SURVIVAL OF THE DIFFERENT DEVELOPMENTAL STAGES OF THE FEMALE FOLLOWING SETTLING AND FORMATION OF THE SCALE COVER

The first instar included both males and females; later stages were females only. The number of females settling was estimated by multiplying the total number by the proportion of females given above, 0.452. The number of second-instar females was calculated in a similar way from the total number of scales completing the first molt

		Survival of immature stages			Survival of females from settling to reproducing	
Host	Number settled	Per cent which completed first molt	Per cent first instar females which survived first and second instars	Per cent second instar females which completed second molt	Estimated number which settled[1]	Per cent which reproduced
Latania	369	85.4	79.6	93.0	450	59.0
Camphor	445	80.4	34.8	43.2	89	34.8
Cycas	119	—	—	—	110	60.4
Satsuma[1]	479	77.0	57.6	74.9	408	36.3

[1]These include a part of the scales listed in the immature survival, and some additional ones.

Records on reproduction were obtained from periodic removals of newly emerged nymphs on potted plants infested with a known number of females. At the time of examination some nymphs had settled and started to form covers while others were still active crawlers, some of which would not have settled. The data, therefore, lead to estimates lower than the actual egg production but somewhat higher than the number settling and forming covers. The summaries are given in Table 5.

TABLE 5. PRODUCTIVITY OF FEMALE *Chrysomphalus dictyospermi* ON VARIOUS HOSTS

Host	Number of females	Number of progeny	Average per female
Latania	21	839	40.0
Camphor	71	3,847	54.2
Cycas	47	2,686	57.1
Satsuma	35	3,501	100.0

The figures on latania include 5 single females which produced an average of 50 young, the variation ranging from 20 to 79 per female.

The relative susceptibility of these hosts can be estimated, from Tables 3, 4, and 5, on settling, survival, and productivity, by calculating the number of progeny which would be expected from 100 crawlers set out on each host and permitted to mature and reproduce. (Table 6.)

TABLE 6. PROGENY EXPECTED FROM 100 CRAWLERS OF *Chrysomphalus dictyospermi* ON RESPECTIVE HOSTS. IT HAS BEEN ASSUMED THAT 45.2 PER CENT OF THESE CRAWLERS WERE FEMALES

Host	Number of female crawlers	Number of females settled	Number of re-producing females	Progeny next brood
Latania	45	34.8	20.5	820
Camphor	45	33.7	11.7	634
Cycas	45	26.1	15.8	902
Satsuma	45	32.6	11.8	1,180

On cycas, the high survival after settling compensated for the high mortality of crawlers, while the reproductive rate on Satsuma gave the highest progeny of all in spite of the low survival between settling and beginning of reproduction. On the first three hosts this estimate agrees with qualitative field observations, heavier infestations being found on cycas than on camphor. The scale has not yet become established in the citrus growing sections of this State, but the foregoing data show that it might be a serious pest of Satsuma under Louisiana conditions.

SEASONAL HISTORY AND NATURAL ENEMIES.—In the insectary from five to six broods a year were produced. In the counts made from the field, however, all stages of the insect were found throughout the year, so it was not possible to separate the different broods of the insect. Hence no check on prediction of succession of stages in the field can be

made from insectary data, nor would such prediction have any value from the standpoint of control practices.

The insect is attacked by a number of natural enemies, the following parasites having been recovered: *Aphelinus chrysomphali* (Mercet), *Prospaltella aurantii* (Howard), *Signiphora merceti* (Malenotti), and *Signiphora flavopalliata* Ashmead.

In contrast to the camphor scale, which is usually killed in the second instar when parasitized, *C. dictyospermi* is ordinarily not killed until it has produced some young. Thus 5 parasitized females in the insectary produced an average of 20 young per female. Parasites, therefore, are not very effective agents of control. The coccinellid beetles *Rhizobius debilis* Blackburn and *Lindorus lophanthae* Blaisdell, although not

TABLE 7. SPECIFICATIONS OF SPRAYS WHICH GAVE 100 PER CENT CONTROL OF *Chrysomphalus dictyospermi* ON INDICATED HOSTS

Oil specification	Emulsion type	Oil concentration in spray Per cent	Scale host
1. Density, 0.894 Viscosity, 208 secs. (Saybolt) Volatility (4 hrs. at 105°C. or 221°F.), 0.1 per cent Unsulphonated residue, 60%	Oil, 2 gals.; potash fish-oil soap 2 lbs.; water, 1 gallon; boiled and pumped	1	Podocarpus
2. Density, 0.845 Viscosity, 86 seconds (Saybolt) Volatility (4 hrs. at 110° C. or 230°F.), 1.58 per cent Unsulphonated residue, 97%	do	1	Cycas revoluta
3.[1]Density, 0.883 Viscosity, 102 secs. (Saybolt) Volatility (4 hrs. at 110°C. or 230°F.), 0.16 per cent	Potash fish-oil soap and fusel oil, cold stirred (*11*)	1.3	Latania commersoni Citrus sinensis

[1]The third oil was applied by W. D. Whitcomb.

generally distributed, are more efficient and attack all stages. In 1926, an infestation on a Cycas which was being used for seasonal-history counts was completely destroyed by predators.

Counts were made from another infestation during 1927 when the natural mortality averaged around 45 per cent in the winter and from 15 to 30 per cent during the rest of the year.

ARTIFICIAL CONTROL.—The scale is easily controlled by spraying with oil emulsions. Tests with the following oils (Table 7) have given 100 per cent mortality:

All of the foregoing sprays were applied with a bucket pump at about 50 pounds' pressure. The second emulsion showed an average drop size of 5.78 ±24 microns, with a maximum drop size in 273 droplets counted of 21.5 microns. Drop counts were not made on the others, but the first was prepared in identical manner while those of the type of the third were generally more stable than the standard boiled emulsions. All these sprays were applied in the summer without injury to the plant.

Summary

Biological and control studies on *Chrysomphalus dictyospermi* (Morgan) are reported.

No evidence was found for the existence of the varieties which have been described.

The range in the length of the incubation period indicates that the eggs are deposited at various stages of development.

The emergence of crawlers from beneath the parent scale showed a marked diurnal periodicity, the peak of emergence occurring between 8 and 9 a.m.

The rate of development was found to be largely a function of temperature.

No difference in the lengths of the instars was found on four different hosts, but data on survival and productivity indicated that susceptibility to the scale would be in the following order: Satsuma orange, Cycas, Latania, camphor.

More males than females were produced, and fertilization was necessary for reproduction.

In the insectary from five to six broods a year were produced. In the field all stages are present throughout the year, and distinct broods can not be distinguished.

A number of parasites have been observed to attack the scale, but these are not effective agents of control, since usually the scale is not killed until after it has produced a considerable number of young. More effective but not generally distributed are the coccinellid beetles *Rhizobius debilis* Blackburn and *Lindorus lophanthae* Blaisdell, which attack all stages.

One hundred per cent mortality was obtained in sprays with oil emulsions, with oils of widely different character, using from 1 to 1.3 per cent of oil.

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THE PHASES OF THE ROCKY MOUNTAIN LOCUST *MELANOPLUS MEXICANUS* (SAUSSURE)

By JACOBUS C. FAURE,[1] *Professor of Entomology, University of Pretoria, South Africa*

A FOREWORD

Dr. Faure has shown experimentally (1932) that the brown locust, *Locustana pardalina*, of South Africa exists under two phases, the solitary phase and the swarm phase. Each of the individuals of the solitary phase, which live in isolation like most

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common grasshoppers, is a representative form of the phase *solitaria*. Each of the individuals of the swarm phase, which come together in great dense swarms and then migrate over the country, is a representative of the phase *gregaria*.

The nymphs of the phase gregaria differ markedly from the nymphs of the phase solitaria in coloration, while the adults of gregaria differ in several morphological characters from the adults of the phase solitaria. Dr. Faure, by means of an ingenious series of experiments, has been able to transform the progeny of the solitaria phase into the phase gregaria. There is, therefore, now no doubt of the fact that the transformation of this grasshopper from one phase into the other phase occurs in nature when the conditions are present to bring it about.

It has been suggested recently by several authors that our Rocky Mountain locust *Melanoplus spretus*, now apparently extinct, was the long winged migratory (*gregaria*) phase of our common grasshopper *Melanoplus* (*atlanis*) *mexicanus*. Dr. Faure conceived the idea of attempting, by his experimental methods used so successfully with the brown locust of South Africa, to transform *M. mexicanus* which he surmised to be the *solitaria* phase into *M. spretus*, the phase *gregaria*. The following paper embodies the results of Dr. Faure's observations on *M. mexicanus* in rearing experiments carried out at Saint Paul, Minnesota, during May, June, and July 1932.

GLENN W. HERRICK

MATERIAL AND TECHNIQUE.—During the summer of 1931 there were serious outbreaks of grasshoppers in Minnesota, North Dakota and adjoining states, but *M. mexicanus* was not known to have occurred anywhere as the predominant species. Early in the spring of 1932 I made enquiries with a view to locating egg deposits of this species, but unfortunately neither the Federal nor the State authorities had any detailed knowledge of places in which eggs could be obtained. Under the guidance of Dr. Parker I went to Minot, North Dakota early in May, and collected about 8–9,000 eggs of what we hoped were *M. mexicanus*. Some of the eggs were already hatching, therefore they were packed on ice for transportation to Saint Paul. Unfortunately it transpired a few weeks later that about 95 per cent of the nymphs hatching from these eggs were those of *Melanoplus packardi* Scudder, one of the less important pest species whose eggs are apparently indistinguishable from those of *mexicanus;* the result was that I had only a few hundred nymphs of *mexicanus* to work with.

The collection of newly hatched nymphs was also seriously considered, but owing to the limited time and facilities at my disposal no serious effort was made in this direction. As with the collection of the eggs, one was faced with the difficulty of not knowing just where to look for *mexicanus*, and in addition there were the factors of uneven hatching of the eggs, and the difficulty of distinguishing the nymphs from those of some of the other Melanopli. If the need had been for nymphs of the fourth or fifth instars, this method would have been worth while, but for my purposes I had to have nymphs of the first instar.

In general the methods followed in the rearing experiments, and the cages used, were the same as those recently employed and described by the writer (Faure 1932). Owing to the small numbers of *mexicanus* available, the "crowds" were reared in a new type of small rectangular cage made of wood, celluloid, wire gauze and glass. Two sides and the top were made of celluloid with the idea of forcing the insects into close contact with one another by reducing the area of vertical walls on which they could walk; experience showed that the celluloid was of no value in this direction, for the nymphs walked on the celluloid sides almost as readily as on the wire gauze, even in the fifth instar. In the case of the African species only first instar nymphs were able to walk on vertical glass or celluloid. These celluloid cages were about 6 inches high, and the dimensions of their floors were about 3 by 4½ inches. Owing to the small size of the first instar nymphs the wire gauze used in all types of cages was material of 18 meshes to an inch.

The eggs were placed on moist sand in fruit jars, and kept in an incubation chamber at a constant temperature of 32° C. No attempt was made to control or record the conditions of temperature and humidity under which the rearing was done. During the day-time the cages were kept outdoors in sunny, warm weather. At night and on cool or rainy days, they were placed in a greenhouse that was usually heated to about 80–90° F. in the day-time. Towards the end of the rearing period, in July, there was a spell of very hot weather, with shade temperatures up to 100° F.; during this period the cages were kept in the greenhouse because the heat seemed to be more endurable there (at least to the observer!) than outdoors. The food consisted mainly of young wheat and maize leaves.

THE DIFFERENCES BETWEEN THE PHASES *gregaria* AND *solitaria*.—In

EXPLANATION OF PLATE 29

Melanoplus mexicanus (Saussure)
Louise Fulton del.

1. ph. *gregaria* ♀ 4th instar, from cage containing a crowd (x 2)
2. ph. *solitaria* ♀ 4th instar, reared in isolation in a wire gauze cylinder (x 2)
3. ph. *gregaria* ♀ 5th instar, from cage containing a crowd (x 2)
4. ph. *solitaria* ♂ 5th instar, reared in isolation in a celluloid cylinder on growing wheat (x 2)
5. ph. *solitaria* ♀ 5th instar, reared in isolation in box painted white (x 4)
6. ph. (?) *gregaria* ♀ 5th instar, from cage containing a crowd (x 2)
7. ph. *solitaria* ♂ 5th instar, reared in isolation in box painted yellow (deep chrome, Ridgway) (x 4)
8. ph. (?) *transiens* ♂ 5th instar, reared in isolation in box painted brown (auburn, Ridgway) (x 4)

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Melanoplus mexicanus (Saussure).

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the African species of migratory locusts very striking differences in nymphal coloration are known to occur, depending upon the density of the population both in the field and in breeding cages. The phase *gregaria* is characterized by a definite, constant pattern of orange and black, whereas the phase *solitaria* shows a great variety of colour types such as gray, brown, green and various kinds of variegated patterns (Faure 1932, coloured plates).

The excellent black and white illustrations published by the United States Entomological Commission (1878, first report plates I and III) show very clearly that the differences between the forms *spretus* and *mexicanus* (=*atlanis*) in nymphal coloration are of the same order as the differences between the phases *gregaria* and *solitaria* in the African species. The figures of *spretus* nymphs show much more solid black on the pronotum than those of *atlanis*. In comparing the two forms, the Commission states that *spretus* has the most black and that its black face is quite characteristic, but no special mention is made of orange as a characteristic feature of this form.

The coloured figures reproduced herewith represent the differences between the phases of *M. mexicanus* as observed in the rearing experiments described below. The characters differentiating the nymphs of the phase *gregaria* are:

1) the larger black areas on the pronotum and the hind femora which are solid black in typical examples;

2) a strong contrast between the black and non-black areas of the head and pronotum; the non-black portions may be orange, yellow, pale gray or almost dirty-white;

3) the black face, seen mainly in nymphs of the second, third and fourth instars.

The *solitaria* nymphs are very variable, but they lack the large pitch black areas and their general colour tends to be a kind of gray or brown mottled with black specks; they lack the strong contrast between the black and orange (or pale gray) of *gregaria*. It should be noted that the subdorsal black areas on the pronotum tend to persist in some types of *solitaria* nymphs; on casual examination some of these nymphs could be mistaken for *gregaria* nymphs, but examination under a hand lens will show that the subdorsal "black" areas are not solid black, and often the appearance of black is due to a large number of brownish spots close together. In some of the *solitaria* nymphs a certain amount of black was also found to persist on the hind femora and on the wing-pads.

The phase *transiens* is difficult to define, even in the African species in which the differences between the phases *gregaria* and *solitaria* are

well known; in the case of *mexicanus* my limited experience did not enable me to recognize the phase *transiens* with any degree of certainty. Nymphs showing a development of black more or less intermediate between *solitaria* and *gregaria* were described as *transiens*.

At Lockhart, Minnesota about 75 nymphs were collected on June 29, 1932 with the adults listed in Tables 2 and 3. About 75 per cent of these showed good *gregaria* characters, and the rest were considered as representing *transiens* types.

NYMPHS REARED IN CROWDS.—As the nymphs hatched they were transferred from the egg jars to the rearing cages. Some were reared in isolation, as described below, and the rest were kept together in order to note the effects of crowding. The number of nymphs obtained, about 7,500 to 8,000, was sufficient to fill several of the larger cages of wood and wire gauze (size 18 x 9 x 15 inches), consequently four of these and three of the "new" celluloid type (size 6 x 3 x 4½ inches) were used for the material hatching from eggs brought in from the field.

When the nymphs were about two weeks old I realized that the great majority were *M. packardi;* those of *mexicanus* were therefore caught out of the seven cages and placed together into two of the small celluloid cages. At this time the *mexicanus* nymphs were mainly in their third and fourth instars, and some of them had already reached the fifth instar. It follows that the insects had completed about one-half of their nymphal development before they were placed together in "pure-culture" crowds consisting of *mexicanus* only. They lived under crowded conditions throughout their nymphal life, but the quality of the resulting activity was undoubtedly not the same during the first half of their development as it was during the second, because the nymphs of *packardi* are definitely less active than those of *mexicanus*.

The details concerning the cages containing both species are not of sufficient interest to include here, therefore only the crowds of *mexicanus* will be briefly discussed. Into cage No. 103 (size 6 x 3 x 4½ inches) we put 111 nymphs on June 13th, all in the fourth instar; about 78 per cent were described as having black faces and being of the *gregaria* tvpe, and 22 per cent as being more or less of the *solitaria* type. On June 24th there were only about 50 nymphs left, all in the fifth instar, and these were described as showing about 90 per cent *gregaria*, with orange and yellow in addition to more or less solid black markings. By July 13th all the nymphs had become adults; 39 adults from this cage were measured for biometrical data as described below.

Cage No. 107 (size 6 x 3 x 4½ inches) received 200 nymphs on June 13th, of which 145 were in the third instar, 25 in the fourth, and 30 in the

fifth instar; about 76 per cent of these nymphs were described as *gregaria* and 24 per cent as *solitaria*. On June 24th about 60 nymphs of the third to the fifth instars remained alive in this cage, and they were described as about 50 per cent *gregaria*. Out of this cage 42 adults were measured.

In addition to Nos. 103 and 107 there were two other crowds in celluloid cages of approximately the same size. Cage No. 1 contained a mixed lot of nymphs collected in their first and second instars in the field on May 13th to 16th; about 400 were originally placed in this cage, and 36 adult *M. mexicanus* were recovered from it for measuring. Cage No. 144 received about 130 nymphs of *mexicanus* picked from a mixed lot of Melanopli received from Mr. R. L. Shotwell from South Dakota; 44 adults from this cage were measured. In both No. 1 and No. 144 about 50 per cent of the nymphs of *mexicanus* developed a type of coloration that was distinctly *gregaria* in character.

In all cages containing crowds of nymphs of *mexicanus* there was distinctly more activity than in the cages containing single individuals, but the crowd activity was exceedingly poor compared with that of *Locustana pardalina* (Walker) and *Locusta migratoria migratorioides* Rch. and Frm. Even on very hot days in bright sunshine I never saw the kind of continuous jumping in *mexicanus* that is so characteristic of the nymphs of these two African species when reared under crowded conditions. The *mexicanus* nymphs walked up the sides of their cages more or less actively in hot weather, and they displayed a certain amount of quarreling over food; their activity was approximately the same as that observed in nymphs of *Schistocerca gregaria* (Forsk.) in cages in South Africa.

Nymphs Reared in Isolation.—Experience in rearing *Locustana pardalina* has shown that the effects of an isolated existence can be studied satisfactorily only when not more than one individual is confined in a cage. In all the experiments with *M. mexicanus* this principle was strictly adhered to.

Three types of cages were used in the isolation experiments: (1) cylinders of wire gauze, size about 6 x 3 inches, tacked to a piece of board; (2) cylinders of celluloid, size about 7 x 3 inches, covered with calico and pressed into soil over growing young wheat plants; (3) painted wooden boxes, size 6 x 3 x 3 inches, with glass lids running in grooves.

The nymphs were placed in isolation a day or two after hatching; when deaths or losses due to other causes occurred replacements were made with nymphs from cages containing crowds, but about ten days after the eggs had all hatched there were no more nymphs of the first

instar available, therefore some individuals were not isolated until they had reached the second stage.

A total of 70 nymphs were reared in the three types of cages and taken into consideration in evaluating the effects of this kind of existence; of these 48 were in isolation from the first to the fifth instar, 6 were reared from the first to the fourth instar, and 16 from the second to the fifth instar. These 70 nymphs were classified in their fourth or fifth instars as follows:

solitaria 61 or about 87 per cent
? *transiens* 9 or about 13 per cent
gregaria none

Attempts to Produce Green Nymphs.—The celluloid cylinders over growing wheat plants were used in order to note whether rearing in this type of environment would result in the production of green nymphs. Only three nymphs of *mexicanus* developed a distinctly green coloration in these cages, out of a total of 33 reared in them, and a fourth was described as greenish yellow; this means that approximately 9 per cent of the nymphs became green when reared in a moist atmosphere on a constant and abundant supply of succulent food. The nymphs referred to as being green were similar to those of *L. pardalina* in that only certain parts of the body became green; the dark markings such as those on the pronotum and hind femora that are characteristic of the species usually persisted on the green nymphs as well as on the grays and other types of *solitaria* nymphs.

Out of 75 nymphs of *mexicanus* collected at Lockhart, Minnesota, under outbreak conditions[2] on June 29th, 7 were found that were distinctly green, i.e., again about 9 per cent. The conditions under which these nymphs developed had not been observed before June 29th, but on this date there was still an abundance of green food and a moderately dense growth of weeds and grasses, therefore I assume that the conditions had been favourable for the development of the green colour. The occurrence of about 9 per cent green individuals in a random field sample, and the production of 9 per cent green nymphs in the celluloid cages indicate that approximately this percentage of *mexicanus* nymphs will become green under suitable conditions. As reported elsewhere, a much larger percentage of the nymphs of *Locustana pardalina* and *Locusta m. migratorioides* became green when reared in the celluloid cylinders on growing food (Faure 1932).

Nymphs Reared in Painted Boxes.—Out of the total of 70 nymphs

[2]The U. S. Entomological Commission reported that green nymphs occurred in *spretus* (first report, page 281).

reared in isolation, 22 were confined in painted boxes during their development from the first or second to the fifth instar. These cages were made of wood, and painted on their inner surfaces with ordinary commercial oil paints. After the paint had dried and the cages had been in use for some weeks, the colours were compared with and named according to the tints on the plates of Ridgway (1912) which they resembled most closely.

The colours used were very similar to those used in Africa; those which had given positive results in the African experiments were chosen, i.e., white, black, gray, yellow and brown, and in addition a few tests were made on orange and orange plus black. The treatment of the nymphs, and the method of arriving at the results were the same as those described in my recent paper (Faure 1932).

As shown in Table 1, the nymphs of *mexicanus* proved to be remarkably susceptible to the influence of the various colours of the backgrounds; the results were fully as conclusive as those obtained with *L. pardalina* and *L. m. migratorioides*.

TABLE 1. NYMPHS REARED IN PAINTED BOXES FROM THE FIRST TO FIFTH OR SECOND TO FIFTH INSTAR

Colour of box (Ridgway's nomenclature in parentheses)	Nymphs, classified according to the degree of resemblance to the colour of the background				
	None	Slight	Fair	Good	Total
White	–	–	1	4	5
Black	–	–	1	1	2
Gray (light mouse)	–	–	2	2	4
Yellow (deep chrome)	–	–	–	4	4
Brown (auburn)	–	–	3	2	5
Totals	–	–	7	13	20
Percentages	–	–	35	65	

In addition to the nymphs listed in Table 1, 6 others were reared in colour boxes from the third to the fifth instar; these 6 are not included in the total of 70 reared in isolation to which reference is made above. Of the six, two were noted as showing good resemblance to the background, one on gray and the other on yellow; two were described as cases of fair resemblance, one on black, and one on orange (rufous of Ridgway pl. xiv); two showed slight resemblance only, one to orange in an orange box, the other to orange only in a box painted black and orange.

Besides the 20 listed in Table 1, two others were reared from the 1st and 2nd instars, respectively, to the 5th instar in boxes painted black and orange; both of these were noted as showing fair resemblance to orange only.

A BIOMETRICAL STUDY OF THE ADULTS.—I am indebted to Mr. James A. G. Rehn of Philadelphia, the well known orthopterist, for the following summary of the structural differences between *spretus* and *mexicanus*:

"The only characters which seem to be of value in separating *spretus* from *mexicanus* are the greater size, relatively longer wings, and slightly more expanded posterior part of the pronotum of the former. Minute characters in the form of the cerci and the apex of the sub-genital plate were given by Scudder as additional features, but these appear to be individual fluctuations appearing as regularly in true *mexicanus*."

In view of the small size of the species (as compared with the African migratory locusts), and the comparatively trivial differences in the pronotum of *spretus* and *mexicanus*, I have not attempted to take measurements of the pronotum and the head. The only character which appeared to me to be readily measurable was the relative length of the wings. It need hardly be pointed out that measurements of the portion of the wing projecting beyond the tip of the abdomen are of doubtful value in view of the structural peculiarities of the abdomen.

I have measured the length of the hind wing and the length of the hind femur, and have used the ratio wing/femur as an expression of the relative length of the wing. The averages are also included in Tables 2 and 3, since they serve as indices of the absolute size of the specimens in the different series. For the methods of taking measurements and arriving at the results the reader is referred to my recent paper (Faure 1932). In the work on *mexicanus* the measurements were taken to the nearest quarter of a millimeter (0.25 mm.).

DESCRIPTION OF MATERIAL.—Tables 2 and 3 comprise the averages and ratios resulting from the measurements of seven series of specimens. Series i consisted of "*M. spretus*" from the United States National Museum in Washington and the Academy of Natural Sciences in Phila delphia; a number of the specimens were from the collections of C. V. Riley and S. H. Scudder; the dates varied from 1868 to 1899, but the majority were collected in the seventies of last century; the specimens came from many different localities in the region invaded by swarms.

Series ii were specimens collected by the writer at Lockhart, near Ada, Minnesota, on June 29, 1932. The grasshopper outbreak in the Red River Valley of Minnesota was mainly due to other species in 1932. but *mexicanus* was found to predominate in a few localities. At Lockhart the adults of *mexicanus* were so abundant that one could easily catch 30–40 in about a dozen sweeps with the net on a cool morning. Entomologists who saw them in the field were struck by their pale appearance and the length of their wings. The best descriptive term I

can suggest for the material of series ii is that it came from an incipient swarm. The outbreak was apparently confined to a few hundred acres, but *mexicanus* was undoubtedly present in "outbreak" numbers sufficient to attract the attention of officers concerned with the campaign of destruction that was in progress at the time.

TABLE 2. MALES: AVERAGES AND RATIOS OF BIOMETRICAL DATA. MEASUREMENTS IN MM., TO 0.25 MM.

Series	Description	Number measured	Ratio A/F wing/femur	A. Average wing length	F. Average femur length
i	"*M. spretus*" U.S.N.M. and Philadelphia	31	1.897	24.78	13.06
ii	Lockhart, Minn. 29. vi. 1932	51	1.710	20.50	11.99
iii	Barnesville, Minn. 28 vi. 1932	17	1.703	21.37	12.54
iv	"*M. mexicanus*" U.S.N.M. and Philadelphia	15	1.569	18.20	11.60
v	St. Paul, Minn. July 1932	34	1.656	18.77	11.34
vi	Cage-reared: crowded	75	1.585	17.10	10.79
vii	Cage-reared: isolated	37	1.536	16.82	10.95

Series iii were specimens taken at Barnesville, Minnesota, on June 28, 1932. Conditions here were similar to those at Lockhart, but *mexicanus* was not quite so dominant in numbers as at the latter place.

Series iv consisted of specimens of "*M. mexicanus*" from the collections of the United States National Museum and the Academy of Natural Sciences in Philadelphia, taken in widely scattered localities in the United States, and in many different months and years. This series represents the extreme solitary phase in its short-winged form. Although the data on the pins did not indicate the density of population obtaining at the time when the specimens were collected, it is probably safe to assume that they were not taken under "outbreak" conditions.

Series v comprised specimens collected in and near Saint Paul, Minnesota, in July 1932, by Mr. H. A. Tinkham and the writer. There had been no suggestion of an outbreak within ten miles of the fields in which this material was collected, and the population was so scattered that one collector could not catch more than about 25 specimens in three hours. The insects were all collected as adults, but they were fresh, perfect specimens, and it does not seem remotely probable that they could have flown from a distance from some unreported outbreak. I consider that they must have developed as nymphs under conditions of complete isolation, and that they therefore represent the true phase *solitaria* of the species. In view of the fact that the females of *mexicanus* are very similar to those of *femur-rubrum*, I submitted all the females of this series to Mr. James A. G. Rehn who very kindly confirmed the identifications for me.

Series vi and vii consisted of the adults from the rearing experiments discussed in preceding paragraphs of this report.

DISCUSSION OF THE DATA.—The figures in Tables 2 and 3 show clearly that the *spretus* material exceeds all the other series in absolute size, as indicated by the averages of wing length and femur length, and in the relative length of the wings as reflected in the ratio wing/femur.

Series ii and iii show a definite variation in the direction of *spretus* in both sexes with ratios in the column A/F that are distinctly higher than those of series iv and v.

TABLE 3. FEMALES: AVERAGES AND RATIOS OF BIOMETRICAL DATA. MEASUREMENTS IN MM., TO 0.25 MM.

Series	Description	Number measured	Ratio A/F wing/femur	A. Average wing length	F. Average femur length
i	"*M. spretus*" U.S.N.M. and Philadelphia	31	1.804	25.85	14.33
ii	Lockhart, Minn. 29. vi. 1932	50	1.668	21.45	12.86
iii	Barnesville, Minn. 28. vi. 1932	16	1.669	21.03	12.60
iv	"*N. mexicanus*" U.S.N.M. and Philadelphia	13	1.526	20.03	13.13
v	St. Paul, Minn. July 1932	21	1.607	20.32	12.64
vi	Cage-reared: crowded	94	1.509	17.13	11.35
vii	Cage-reared: isolated	16	1.500	16.84	11.22

Series iv gives the lowest ratio A/F of all the field material in both tables. A very interesting point is brought out by the figures for series iv and v, indicating that there is considerable variation in the relative wing-length of specimens of this species developing in the field under conditions of isolation. Possibly there may be geographical races of short winged forms and longer winged forms in different regions; or the variation may be due to seasonal fluctuations in temperature and rainfall acting through the moisture content of the food as suggested by the results obtained by Parker (1930) in rearing experiments.

The ratio A/F of the series v is distinctly lower than the ratios of series ii and iii in both sexes, indicating that the far greater density of population at Lockhart and Barnesville was the factor which produced the longer wings in series ii and iii.

In series vi and vii we note that the specimens reared in the cages were decidedly smaller in both sexes than the field material. In relative wing-length those reared under conditions of crowding gave a slightly higher ratio than the individuals reared in isolation, indicating a tendency to vary in the direction of *spretus*, but this ratio was still distinctly lower than that obtained from series v. The failure of the cage-crowded material to show a wing/femur ratio equal to or greater than that of the

solitaria series from the field (series iv and v) does not invalidate the main conclusions arrived at below. It should be borne in mind: 1) that the cages were exceedingly small; 2) that the crowding was experienced for one nymphal development only, and 3) that the *mexicanus* material was mixed with a preponderating number of *M. packardi* nymphs during the earlier stages. If the rearing under crowded conditions were carried out with larger numbers, in larger cages, and through four or five generations, a distinct increase of relative wing length as compared with field *solitaria* material would probably be obtained.

CONCLUSION.—The observations and experiments described in the preceding paragraphs warrant the conclusion that the form considered by the United States Entomological Commission as a distinct species, and long known as *Melanoplus spretus* (Walsh) was the phase *gregaria* of *Melanoplus mexicanus* (Saussure). The name *spretus* Walsh 1866 is therefore a synonym of *mexicanus* Saussure 1861. This conclusion is based on the following facts:

1. In rearing experiments, the type of nymphal coloration described by the U. S. Entomological Commission as typical of *spretus* appeared only in cages containing crowds, whereas the nymphs reared in isolation acquired types of coloration similar to that described by the Commission for *mexicanus* (=*atlanis*).

2. Adults of *mexicanus* taken in Minnesota in June 1932 under outbreak conditions showed a strong tendency to vary in the direction of *spretus* in relative wing-length and in size.

3. There is a close similarity between the relationships of *spretus* to *mexicanus* and those obtaining between the phases *gregaria* and *solitaria* in the African species of locusts.

In view of the small amount of material that was available for the writer's experiments, and the fact that his observations covered one nymphal development only, it is desirable that further comparative studies be undertaken with large series of *mexicanus* reared under conditions of crowding and isolation. It would be particularly interesting to note the effects of rearing several successive generations of the same stocks under crowded conditions.

Another field of inquiry is offered by certain economic species which seem to occupy a position intermediate between the true solitary grasshoppers and the migratory locusts in the sense that they become exceedingly abundant and even undertake short mass-flights without actually forming swarms and migrating long distances. I refer to *Melanoplus bivittatus* (Say), *M. differentialis* (Thomas) and *Camnula pellucida* (Scudder). Fragmentary observations made in Minnesota

in 1932 suggest that the nymphs of *differentialis* may show a tendency to develop a type of coloration similar to that of the phase *gregaria* of true locusts when reared under conditions of crowding. Finally I wish to call attention to the desirability of studying the effects of crowding and isolation upon the nymphs of *Schistocerca americana* (Drury). It may prove to be the solitary phase of the migratory locust of South and Central America, *Schistocerca paranensis* (Burmeister).

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VAPO DUST—A DEVELOPMENT IN SCIENTIFIC PEST CONTROL

By WILLIAM B. PARKER, *Entomologist, Research Department—California Spray-Chemical Corp., 15 Shattuck Square, Berkeley, Calif.*

Vapo Dust[1] and the Vapo Dust Machine are new developments in Scientific Pest Control. By this process Phytonomic Oils,[2] alone or containing concentrated insecticidal or fungicidal materials, are diluted with air to form a fog that envelops pest-infested plants or trees in such a way as to rapidly, economically, and completely cover them with a thin and uniform film of very active material.

The application of pure oil as an insecticide is not new. Matthew Cook used kerosene in killing San Jose Scale as early as 1882 and it was later recommended by Professor J. B. Smith in 1897 as follows: "The essential points to be regarded in the application of pure kerosene are, the finest possible spray, the completest and thinnest possible coating over the entire surface, the weather conditions favoring rapid evapora-

[1]The term Vapo Dust is a registered trade mark of the California Spray-Chemical Corporation.

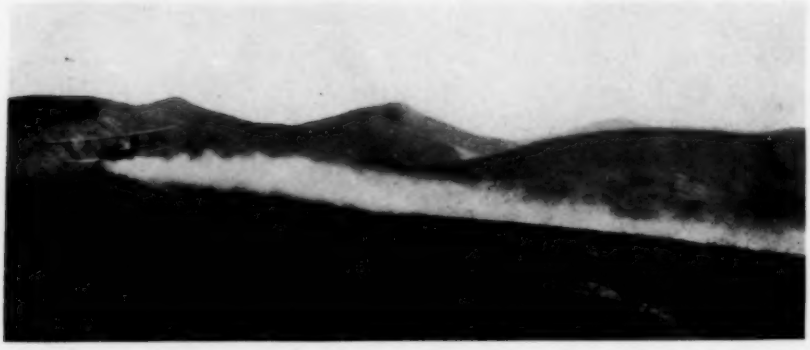
[2]Phytonomic oil may be defined as an oil that can be safely applied to plant foliage without causing injury. More specifically, it refers to lubricating type oils from which unsaturated hydrocarbons, sulphur, the more sensitive cyclic hydrocarbons, acids having organic nucleii, and more volatile bodies, and other chemically active bodies that would cause injury to foliage have been removed.

1. Demonstration Vapo Dust Machine used to apply oils as a winter spray on deciduous fruits. This machine will do four to six acres of orchard per hour. A thin film of oil is uniformly applied to every part of the tree.

2. Vapo Dusting Grapes for Leaf Hopper in the San Joaquin Valley, California. About fifteen of this type of machine and many smaller outfits are now in practical use.

Plate 31

3. Applying Vapo Dust to large prune trees in the Santa Clara Valley for the control of the Brown Apricot and Stahan Pear Scales.



4. Applying Vapo Dust with an Aeroplane for the Beet Leaf Hopper, Los Banos, California, Feb. 1932. In spite of the fact that it was midwinter, a good kill was obtained.

tion. The trees themselves should be dry. Any departure from these suggestions may cause injury, for I wish it distinctly understood that kerosene, improperly used, is fatal to plant life."

While some of these early results were satisfactory, many of them were not as is indicated by Mr. Johnson of the Maryland Experiment Station at the tenth meeting of the Association of Economic Entomologists at their meeting, when he quoted Captain Emory, one of Maryland's largest and most successful growers, as being convinced that—"pure kerosene, sprayed during the middle of a sunshiny day, in the finest possible mist in the hands of an expert, is surer death to certain trees than the San Jose Scale."

Our experience of recent years with mineral oil sprays would indicate that some of the injury was caused in those earlier days by the relatively crude kerosene available at that time combined with the difficulty of applying the "thinnest possible coating" over the entire surface with the equipment of that period.

This new method eliminates the necessity of hauling large quantities of water and saves consequent loss of time in refilling the spray tank. It also puts the oil on in the most effective manner, the insect being dry, it is immediately drenched by the oil and there is no interference from the water phase of the ordinary spray application.

This process first was developed in an attempt to check a very serious infestation of Grape Leaf Hoppers (*T. comes* Say) in the San Joaquin Valley, California, 1931.

Experiments showed that very small quantities of phytonomic oils, particularly when combined with a small amount of pyrethrum or nicotine were very effective against both nymphs and adults of this insect and that it could be applied without injury to the grape vines.

Fly spray atomizers and paint guns were used in the experimental and small scale work but in order to safely and practically apply this process commercially the Vapo Dust Machine was invented.

This machine not only atomizes the spray material but dilutes it with air and drives it upon the plants and pests. It can be regulated to break a given amount of this concentrated insecticide into the proper sized particles and dilute them in a constant volume of air. By moving the machine at a regular speed (3–8 miles per hour) a definite amount of material can be evenly and rapidly applied. It has been found possible to effectively apply as little as two and one-half gallons of Vapo Dust per acre of grapes in from six to ten minutes.

In cooperation with Mr. E. A. Schwing, Entomologist, Spreckles Sugar Company, and Dr. W. C. Cook of the Bureau of Entomology,

U.S.D.A., some tests were made on the Beet Leaf Hopper (*E. tenella*). The results obtained were so good that the Spreckles Sugar Company treated a large acreage of breeding grounds. Mr. Schwing estimates that they destroyed at least four billion Beet Leaf Hoppers, which resulted in a great saving of sugar beets in 1932. The following fall a larger area of breeding grounds was treated with an estimated destruction of 90 per cent of the "Bug Population" of the San Joaquin Valley of California.

These two campaigns would not have been possible had it been necessary to use an insecticide diluted with water. It would have been impractical to haul water to spray these large isolated areas and, furthermore, a wet spray had not proved effective against this insect.

To date Vapo Dust has been successfully used for Beet Leaf Hopper, Grape Leaf Hopper, Brown Apricot Scale, Red Spider and Thrips on Prunes, Thrips on Onions, Aphis, Thrips and Leaf Miner on Field Peas. Mixed with Bordeaux or Coposil it is being tested during the dormant periods as a combined fungicide and insecticide. The Arsenicals, the Fluorine Compounds, Nicotine, Pyrethrum and other materials will be used with it later for leaf eating insects. This field offers great promise.

Attempts to destroy pests with pure oil have been made in the past, but usually with disastrous results to the plants concerned. With Mr. W. H. Volck's development of the foliage oils and the invention of the Vapo Dust Machine, it is now possible to safely apply straight phytonomic oils alone or combined with concentrated fungicides or insecticides in carrying on work in Scientific Pest Control.

FISH MEAL AS A FOOD FOR CLOTHES MOTHS

By GRACE H. GRISWOLD, *Cornell University*

ABSTRACT

Experiments have demonstrated that fish meal is a food highly satisfactory to larvae of the webbing clothes moth. Insects reared on this material went through their life cycles in a surprisingly short time. With fish meal as the only food supply, a method has been developed for rearing large numbers of clothes moths in gallon-sized cardboard cartons.

About two years ago clothes moths were found infesting fish meal in various departments at Cornell University where experimental work with fishes is being carried on. Since studies were under way at the Insectary on the food habits of the webbing clothes moth, *Tineola*

bisselliella Hum., it seemed advisable to conduct some experiments with this material. A supply of the meal was procured from the University Fish Hatchery and various tests with it were made. This food is evidently adequately supplied with all of the elements necessary for the development of the webbing clothes moth. With only fish meal as food, the insect went through its life cycle in a surprisingly short time, and the death rate was found to be very low. Twenty-five newly-hatched larvae were placed in an incubator and kept at a constant temperature of 77°F. All twenty-five larvae developed to maturity and emerged as adults within less than 60 days after the eggs had been laid. The life cycles varied from 45 to 59 days, with an average of 50.96 days.

Generally, under ordinary conditions, the webbing clothes moth does not become mature until at least three or four months after the egg is laid. Exceptional individuals may pass through their life cycles in a much shorter time, while others may require a year or more to complete their development. Since the present studies were begun, over 900 specimens have been reared to the adult stage in individual vials, with life cycles varying all the way from 54 to 780 days. Even when kept at a constant temperature of about 80°F., the entire developmental period has ranged from 45 to 184 days.

On none of the other foods used has the life cycle been as uniformly short as on fish meal. With no other material tested has every single individual in an experiment completed its development and emerged as an adult. Fish meal, therefore, is evidently a food highly satisfactory to larvae of the webbing clothes moth.

Where large numbers of these insects are used for testing various methods of control, it is often difficult to keep on hand a supply sufficiently large to meet all needs. With fish meal as the sole food supply, an efficient method for rearing clothes moths has been devised at the Cornell Insectary.

Cylindrical cardboard cartons, such as are used for packing butter and cheese, make good rearing cages. The gallon-sized carton is about 7 inches high and 6¾ inches in diameter. The cartons are inexpensive, and, since they can be stacked up on shelves, they occupy very little room.

In the center of a large square of cloth (about 22 by 22 inches) is pasted a circular piece of heavy cardboard, slightly smaller than the bottom of the carton. The cloth is placed in the container so that the cardboard rests on the bottom. A layer of fish meal, about half an inch thick, is spread evenly over the circle of cardboard. The cloth is then folded back against the sides of the carton and the cover is put on. Adults

are admitted to the container through a small opening cut in the cover. This opening is closed on the outside with a piece of cheese cloth secured by a little paste. To infest a new container it is only necessary to catch a few adults in small vials and drop them into the opening in the cover of the carton. The females have easy access to the fish meal and will lay quantities of eggs. At temperatures similar to those of an ordinary living room, adults will begin to emerge within about two months after a container has been infested.

When one wishes a supply of larvae, the carton can be opened and the square of cloth carefully lifted out. In this way, the entire contents of the carton can be removed without disturbing the layer of fish meal, which rests on the circle of cardboard in the center of the cloth. Larvae will be found crawling all over the cloth and can be removed with the aid of a camel's hair brush. If the cloth is black, the white bodies of the larvae stand out clearly.

If eggs are desired, all that is necessary is to catch a few adults and place them in a vial with a piece of dark flannel. Since adults shun the light, they will be found hiding in folds of the cloth where they are easy to catch. Some, of course, will escape when the carton is opened. To obviate this, one can have a second piece of dark cloth ready and throw it over the carton as soon as the cover is removed. Adults will hide in the folds of this second cloth as well as in those of the cloth already in the carton. If the folds of the two cloths are turned back slowly and carefully, a number of adults can be caught in a few minutes.

By this method literally hundreds of clothes moths can be reared in a very small space. At the Cornell Insectary, two or three new cartons are infested each month, in order to assure an adequate supply of insects for all needs that may arise. Just how long an infestation will keep itself going, has not yet been determined. If a little fresh fish meal is occasionally added to each container, it seems probable that the various colonies will maintain themselves for a considerable period of time.

A NEW DEVELOPMENT IN THE FIXATION OF NICOTINE[1]

By WARREN MOORE, *Formerly Research Assistant, Rutgers College*

ABSTRACT

A new insoluble nicotine insecticide is prepared by heating an aqueous solution of nicotine, resorcinol and formaldehyde. A finely divided precipitate is obtained. The washed, air-dried product contains about 22% nicotine. The nicotine dissolves in water to the extent of 0.004 gm in 100 cc. It is about one-fifth as soluble as the nicotine in Nicotine Tannate. Prepared as a paste, the new material was mixed with oil and applied to apples by dipping. Its toxicity to codling moth (*C. pomonella* L) was equal to that of Nicotine Tannate. The oil caused it to stick to the apple, so that the deposit was about twice as reistsant to washing with water as was a deposit of Nicotine Tannate.

In a previous communication[2] I have compared Nicotine Tannate and Arsenate of Lead as cover sprays for codling moth, to the advantage of the former. The efficiency of Nicotine Tannate is greatly reduced by the rapid disappearance of nicotine from fruit and foliage sprayed with it.

When vessels are placed under trees, which have been sprayed with Nicotine Tannate, considerable nicotine is recoverable from the water which accumulates after rains. From dry Nicotine Tannate 0.15 to 0.20 gm of nicotine will dissolve in 1000 cc. of water. When Nicotine Tannate is made in the spray tank, some 40% of the nicotine remains unprecipitated. Nicotine Tannate is, accordingly, much more soluble in water than the arsenicals and this is believed to account in large measure for its rapid loss from sprayed trees. Its effectiveness is due to its great toxicity.

Attempts to prevent the dissolving away of Nicotine Tannate by the use of sticking and coating materials have resulted in failure. Only fish oil has given encouraging results. It was felt, therefore, that the discovery of a less soluble nicotine preparation was desirable. Such a substance was prepared, and will be described in this paper.

PREPARATION AND PROPERTIES. The product was made by heating a mixture of nicotine, resorcinol and formaldehyde to 90° C. The voluminous precipitate was filtered by suction and washed with water. A portion was air dried and readily disintegrated into an extremely light, fine powder. The air dried powder contained about 22% nicotine. On treating with water, only 0.004 grams of nicotine dissolved in each 100 cc. Under similar conditions, about 0.015–0.02 gm of nicotine per 100 cc. dissolves from Nicotine Tannate. The air dry material is very difficult to wet with water, but is easily wet by oil, contrasting with Nicotine tannate, which is a hydrophile substance. If the material is treated with a suitable substance, such as flour or milk powder, a dry product can be produced which wets readily and can be used either as a dust or a spray. The wetting agent can be mixed to advantage with the wet filter cake and the entire mass dried together.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology. [2]Journal Economic Entomology *25*, 554–559 (1932).

TABLE 1. EFFECT OF WASHING UPON CODLING MOTH INJURY. TEN LARVAE WERE PLACED ON EACH APPLE. NUMBERS INDICATE THE NUMBER OF INJURIES OBSERVED

Series	Treatment	Before Washing	One Washing	Two Washings	Three Washings
1	Nicotine tannate	1	4	5	
	Nicotine tannate	1	3	7	
2	Nicotine tannate	1	2	4	5
	Nicotine tannate	0	0	3	8
	Nicotine tannate	1	2	4	4
	Nicotine tannate	0	3	4	6
3	Nicotine tannate			5	
	Nicotine tannate			2	
	Nicotine tannate			1	
	Nicotine tannate			3	
	Nicotine tannate			4	
Average					5.75±0.5
1	No. 1 oil	1	3	6	
	No. 1 oil	0	0	2	
2	No. 1 oil	0	2	4	3
	No. 1 oil	2	2	5	5
	No. 1 oil	0	2	2	2
	No. 1 oil	2	3	3	4
3	No. 1 oil			0	
	No. 1 oil			0	
	No. 1 oil			2	
	No. 1 oil			1	
	No. 1 oil			2	
Average					3.50±0.38
	Controls				
1	Nicotine tannate and oil	1	4	6	
2	Nicotine tannate and oil	0	2		
	Nicotine tannate and oil	0	3		
	Nicotine tannate and oil	0	5		
	Nicotine tannate and oil	1	7		
Average			4.2±0.52		
1	Oil	3	3	7	
2	Oil	5			
	Oil	4			
	Oil	5	7		
	Oil	3	7		
Average		4±0.27			
1	Untreated	11	6	9	
	Untreated	6	6	9	
2	Untreated	7	9	6	
	Untreated	4	7	7	
	Untreated	4			5
	Untreated	5			2
3	Untreated		4		
	Untreated		5		
Misc.	Untreated		1		
	Untreated	5	4	7	
	Untreated	6	6	7	
	Untreated	9	8		
	Untreated	9	7		
	Untreated	8	5		
	Untreated	7	6		
	Untreated	7	5		
	Untreated		6		
Average all untreated (36)		6.25±0.23			

Since the material is very insoluble in water and readily wet by oil, it seemed probable that it could be caused to adhere to foliage by the use of oil. Having been "stuck" in this way, its low solubility should prevent rapid loss of nicotine by leaching. That these suppositions are correct is indicated by laboratory tests, a description of which follows.

LABORATORY TEST WITH CODLING MOTH. The washed filter cake, described above, was ground thoroughly with a mortar and pestle to form a smooth paste, which was found to contain 63% water and 7.4% nicotine. To make the spray solution, 2 gm of the paste was dispersed in 300 cc. of water to make a mixture containing 0.05% nicotine. This will be designated as No. 1 in what follows. In some cases an oil emulsion was added at the rate of one part to 200.

Nicotine Tannate was prepared as described by me in an earlier issue of this Journal (loc cit). The spray solution contained 0.0625% nicotine. In some cases the oil emulsion was added as in mixture No. 1.

Small green apples, free from spray residue and codling moth injury, were used in the tests. A rubber band was attached to the stem of each apple. The apples were dipped 30 seconds in the solution to be tested and hung up in the laboratory to dry. A fan was sometimes used to hasten drying. When the apples were dry, each was placed in a small jar with an open top and ten active, newly hatched codling moth larvae were placed on each apple. The following day the apples were examined and the number of injuries (stings plus entries) recorded.

The apples were then soaked 30 minutes in tap water, washed under the tap for one minute, dried and tested with larvae as before. In some cases this was repeated three times. In one series the apples were dried and washed twice before testing.

The observations are summarized in Table 1.

Comparing Nicotine Tannate with the New Product plus Oil, we see no significant difference before washing or after the first washing. A marked difference is evident after the second washing. This becomes very apparent when the apples are grouped according to the number of injuries. This is done in Table 2.

In the No. 1 and Oil column the average cannot be calculated directly because some of the observations have a zero value. The average is represented by the number of injuries occurring most frequently. For Nicotine Tannate this is 4 (the nearest whole number to the average). For No. 1 and Oil it is 2. We may also note that three times as many (63%) of the No. 1 and Oil treated apples show two stings or less as of the Nicotine Tannate treated apples (18%). The data indicates that

the New Product plus Oil is about 2–3 times as effective, after the second washing, as is Nicotine Tannate.

TABLE 2. PER CENT OF APPLES HAVING DIFFERENT NUMBERS OF INJURIES AFTER TREATMENT WITH NICOTINE TANNATE, OR WITH NO. 1 AND OIL, FOLLOWED BY TWO WASHINGS WITH WATER

Number of injuries	Controls No treatment		Nicotine tannate		No. 1 and oil	
0	0	6%	0	18%	18%	63%
1	2.9%		9.0%		9	
2	2.9		9.0		36	
3	0		18.0		9	
4	11.2		36.0		9	
5	16.7		18.0		9	
6	22.2		0		9	
7	22.2		9			
8	5.8					
9	13.9					
10	0					
11	2.9					
12	0					
Average	6.25±0.23		3.82±0.26		—	
No. of apples	36		11		11	
No. of insects	360		110		110	

Passing to the data on the third washing we may compare the averages, since no zero values appear. These are as follows:

Controls—no treatment	6.25±0.25 injuries per apple
Nicotine Tannate	5.75±0.5
No. 1 plus Oil	3.50±0.38

The difference between control and Nicotine Tannate is 0.50±.55. Since the probable error exceeds the difference, no difference is shown to exist. The Nicotine Tannate apples have lost their toxicity.

The difference between the control and the New Product plus Oil is 2.75±0.45. The difference is six times the probable error and, therefore, the odds that the difference is not due to random sampling are better than 1,000 to 1.

We may call this difference (2.75) the "residual toxicity," and dividing it by 6.25, the average for the controls, we get 0.44. We may say that the New Product plus Oil has retained nearly half its toxicity when Nicotine Tannate has lost all its toxicity.

This concludes the experiments on the comparison of the sticking properties of the New Product plus Oil and Nicotine Tannate. It has been demonstrated that the New Product can be "stuck" with oil. When adhesion is effected in this way it is removed by washing with water much more slowly than is Nicotine Tannate. If our belief that such washing is the major cause of loss in the field is correct, we may expect the New Product with Oil to be a much more effective insecticide than Nicotine Tannate.

THE REMOVAL OF LEAD AND ARSENIC SPRAY RESIDUES FROM APPLES[1]

By ALBERT L. WEBER and HARRY C. MCLEAN, *New Jersey Agricultural Experiment Station, New Brunswick, New Jersey*

ABSTRACT

As the result of numerous fruit washing experiments, methods have been devised to satisfactorily and economically remove lead and arsenical residues to meet the new U. S. Food and Drug Administration regulations.

Upon the announcement by the U. S. Food and Drug Administration of a tolerance for lead in foods, the fruit industry faced a very serious problem. Although successful methods for the removal of arsenic have been in use for some time, no work has been done heretofore upon the removal of lead.

Although the arsenical residue tolerance remains at .01 gr. As_2O_3 per lb. and the new lead tolerance is .014 gr. Pb. per lb., the practical effect of meeting the lead tolerance will be to lower greatly the arsenical residue. This is true because the lead and arsenic are applied to fruit in the form of acid lead arsenate which contains 2.76 parts of lead (Pb.) to 1 part arsenic (As.). However, the lead tolerance is expressed as Pb. and the arsenic tolerance is expressed as As_2O_3, making the Pb. to As_2O_3 ratio—2.09 to 1.

In view of previous experiments on and experience with removal of arsenic from apples, it was decided to use only those methods which were found successful in reducing the arsenical residue to fulfill the legal requirements regardless of the degree of difficulty of washing (1, 2).

OBJECT OF THE EXPERIMENTS. The object of these experiments was to find a method that would remove the excess lead as well as arsenic from apples known to be difficult to wash. Any substance used would necessarily have to possess the following attributes: (1) Economical, (2) non-injurious to fruit and workers, (3) effective without heating if possible, and (4) suitable for use with homemade flotation washers or dipping tanks as well as different types of commercial washers.

PLAN OF THE EXPERIMENTS. All washing tests were performed in the laboratory. However, previous experiments have indicated that these methods can be used in all types of washers.

Because of the small quantities of apples available at the time of this work, no tests in homemade and other types of commercial washers could be made.

[1]Journal series paper of the New Jersey Agricultural Experiment Station, Department of Spray Residue Investigations.

The washing method used was made to approximate as closely as possible the washing actions and conditions obtained in a homemade flotation washer. All samples of apples were in contact with the washing solution at 70° F. for 2.5 minutes, except where otherwise noted.

RESULTS OF THE EXPERIMENTS. The results of these experiments are contained in Table 1.

TABLE 1. A COMPARISON OF THE EFFICIENCY OF VARIOUS SOLVENTS ON LEAD AND ARSENIC RESIDUE REMOVAL

	Residue remaining[4]							
	Stayman		Winesap		York Imperial		Rome Beauty	
Washing treatment	Pb. Grs. per lb.	As_2O_3 Grs. per lb.	Pb. Grs. per lb.	As_2O_3 Grs. per lb.	Pb. Grs. per lb.	As_2O_3 Grs. per lb.	Pb. Grs. per lb.	As_2O_3 Grs. per lb.
No treatment	.117	.044	.120	.047	.132	.067	—	—
1.5% HCl[1]	.023	.011	.048	.013	.054	.023	.009	.002
1.5% HCl+1% "Vatsol"	.008	.001	.012	.001	.010	.006	—	—
1.5% HCl+.5% "Alkanol B"	.006	.001	.028	.005	.025	.013	—	—
10% BW Brand Silicate[2]	.038	.009	.035	.005	—	—	—	—
1.0% HCl+.5% "Vatsol"[3]	.005	.001	.007	.003	—	—	—	—
1.0% HCl[3]	.020	.010	.038	.015	—	—	—	—

[1]All percentages given in this paper are on weight basis.
[2]Temperature of washing solution 110°F.
[3]Temperature of washing solution 100°F.
[4]The results given are the averages of the results obtained from several samples.

The York Imperial and Stayman apples used in obtaining the data given in Table 1 were grown in the Glassboro district of New Jersey, and the Winesap apples in Yakima district of Washington. The Stayman and York Imperial apples were sprayed alike, receiving eight cover sprays, three of which contained oil. The Winesap apples were sprayed heavily with lead arsenate also, and because of their very waxy condition, it was very difficult to remove the spray residue. All of these apples were kept in cold storage from the time of picking until used for these tests.

The Rome Beauty apples were grown in the Moorestown district of New Jersey. They were washed at the time of harvest in a flood type of commercial washer. They contained no late oil sprays but were sprayed heavily with lead arsenate.

DISCUSSION OF THE RESULTS. The results obtained from the York Imperial apples are higher than those from the Stayman apples although they were sprayed alike. This may be accounted for by the fact that the York Imperial apples had a heavy coat of natural wax at the

time of the washing tests, whereas the Stayman apples did not. The Winesap apples likewise were heavily coated with wax. This covering of wax probably accounts for the difficulty encountered in removing the lead and arsenic from the Winesap apples with most solvents.

In comparing the relative efficiencies of "Vatsol" and "Alkanol B," it is noticeable that "Vatsol" in conjunction with hydrochloric acid will reduce the lead and arsenic residue within legal requirements whether the fruit was oil sprayed or contained a heavy coat of wax or both. On the other hand, "Alkanol B" is as efficient as "Vatsol" if the apples are oil sprayed but is not sufficiently effective where the apples are coated with wax. Furthermore, the use of "Alkanol B" will not bring the apples within the legal requirements either as to the lead or as to the arsenic tolerances where the apples are covered with both oil and wax.

The use of heat allows a reduction in the quantity of acid and wetting agents. Robinson (3) has stated that a brand of silicate is the only alkali that will remove the lead as efficiently as hydrochloric acid. Langlois (2) has shown that of thirty-three brands of silicate tested, the "BW Silicate" was the most efficient one for the removal of arsenic. The results in Table 1 show that "BW Silicate" when used at a temperature of 110° F. is more effective than hydrochloric acid alone for the removal of arsenic and as effective as hydrochloric acid alone for the removal of lead. However, the "BW Silicate" does not bring the lead residue within the tolerance and is not nearly as efficient as hydrochloric acid used with wetting agents in removing either arsenic or lead.

The use of hydrochloric acid alone is sufficient to remove the lead and arsenic so that the spray residue is reduced to meet the provisions of the Federal Food and Drugs Acts of 1906, provided no late oil spray has been used or the apples do not contain a heavy coat of wax.

CONCLUSIONS. From results obtained in washing experiments it can be concluded that the new lead tolerance can be met under the following conditions: (1) with hydrochloric acid alone where no late oil sprays have been used or no heavy wax coat is present; (2) With "Vatsol" or "Alkanol B" in conjunction with hydrochloric acid where late oil sprays were used, but the fruit has not become waxy; (3) With "Vatsol" and hydrochloric acid where the fruit is heavily coated with wax and may or may not contain oil sprays.

Alkaline washes did not remove lead satisfactorily from apples used in this experiment.

The use of wetting agents with acid gives the washed fruit a clean and attractive appearance while alkaline washes leave the fruit with a dull, cloudy finish.

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Scientific Notes

Length of Adult Life of *Paratrioza cockerelli* (Sulc). It is interesting to note from the following table that the adult potato psyllid is able to survive for a considerable length of time upon various plant species upon which nymphs have not been found to develop. This ability undoubtedly contributes to the successful survival of the adult psyllids from the time potato vines and other breeding plants mature or are killed by frost, until the winter hibernation period. Again, it is of assistance in the spring, supplying a source of food until breeding hosts become available. These data are based upon a limited number of cage tests; it appears likely that the adult psyllids often survive much longer under favorable conditions.

Host plant	Days of life	Host plant	Days of life
Alfalfa	19	Pear	35
Arborvitae	44	Plum	56
Boxelder	28	Rainier Apple	20
Bridal Wreath	56	Raspberry	56
Colorado Blue Spruce	61	Red Clover	56
Currant	26	Roundleaf Mallow	20
Douglas Fir	96	Scotch Pine	93
Grape	20	Snowberry	56
Honeysuckle	17	Sugar-beet	20
Juniper	56	Tree of Heaven	56
Lilac	56		

The majority of the breeding hosts so far noted in Utah are solanaceous plants. Most of these are not available in early spring or late fall.

G. F. KNOWLTON, *Utah Agricultural Experiment Station, Logan, Utah*

Lime-Sulfur Injury Accentuated by Casein Spreader. In commercial trials with casein spreader in 1922, several cases were observed where the spreader apparently accentuated the burning of fruit and leaves with lime-sulfur spray, particularly in pear orchards. The succeeding year cooperative tests on this point were arranged with growers in Georgia, New Jersey, Connecticut, New York, Michigan, Colorado, Washington, Oregon, and California. In each test a pear orchard was given the usual spray of lead arsenate and lime-sulfur and the spreader was used only on certain rows. In eight orchards where injury resulted, it was most pronounced or was confined

entirely to the rows where the spreader was used. It was believed the injury was lime-sulfur burn and not arsenical burn, but this question apparently has remained unsettled. Three observations are here given which indicate definitely that the spreader tends to accentuate lime-sulfur injury: In 1925 a large pear orchard in southern Oregon was divided into plots which received treatments of lime-sulfur, with lead arsenate and casein spreader and without these materials, in various combinations. There resulted a considerable amount of burn which was confined entirely to the plots where the spreader was used, and it was no more pronounced with the spray of lime-sulfur and lead arsenate than with the spray of lime-sulfur only. In the late winter of 1926 an apricot orchard near San Jose, California, was sprayed with lime-sulfur, and casein spreader was used in the spray on part of the grove. The injury to twigs was very severe where the spreader was used. In the early summer of 1932, several rows of plum trees near Pomona, California, were sprayed with lime-sulfur and on a few rows casein spreader was used in the spray. Where the spreader was used the crop was nearly a total loss from spray injury, while on the remainder of the orchard the injury was much less pronounced.

In the three groves cited the severe injury was sharply delimited to the rows where the spreader was used. Prior to 1926 casein spreaders of various brands consisted of approximately 80 per cent hydrated lime and 20 per cent casein. In the last several years some spreaders have been composed of casein, soy bean flour, and hydrated lime. The latter type of spreader was used in spraying the plum orchard in 1932.

RALPH H. SMITH, *Entomologist, University of California Citrus, Experiment Station, Riverside, California*

Otiorhynchus ligustici **L, A European Snout Beetle New to this Country.** In the latter part of April the writer received from H. L. Page, County Agent, Oswego, N. Y. several beetles which were collected from newly set raspberry plants. At first glance they were thought to be the common black vine weevil *O.* (*Brachyrhinus*) *sulcatus*. Closer examination and a careful comparison, however, showed that the specimens were markedly different in character from this well-known weevil. The beetles were taken to Dr. P. P. Babiy who, after a more thorough examination of the literature, identified them tentatively as *O. ligustici* Linn. In our desire, however, to be sure of the species we sent the specimens to Mr. L. L. Buchanan for his identification. He confirmed the conclusion of Dr. Babiy and observed, that the species had not been reported from North America heretofore.

In an attempt to obtain further information concerning this beetle Mr. Page informs me that they came from the farm of Raymond Cooper, R. D. 7, Oswego, N.Y. Although the beetles were originally collected from raspberries they did not come to the farm on these plants. Further examination by Mr. Page in the vicinity in which the beetles were first found disclosed the fact that they were evidently among the grass and weeds where they had probably lately emerged from the soil. The beetles were not abundant and one person, at least, felt fairly sure that he had seen the beetles during the previous summer.

Brehm's Tierleben, vol. 2, fourth edition, p. 502, speaks briefly of *O. ligustici* Linn as follows: It is a black gray scaled species with a keeled snout and finely knobbed, faintly striated elytra. It is a beetle which eats the buds and shoots of many different plants, and has become injurious to peaches, grapes, asparagus, beets and other growing plants. It sometimes attacks clover fields by the thousands. In southwest-

ern Russia the beetles have been observed in great numbers composed entirely of females which had the power of reproducing parthenogenetically.

GLENN W. HERRICK, *Cornell University, Ithaca, N. Y.*

Control of the Birch Leaf-Mining Sawfly. This European sawfly (*Phyllotoma nemorata* Fallen) has been seriously injuring the birch foliage over a large part of Maine since 1927. The eggs are deposited in the mesophyll of the leaf-teeth and the larvae are solitary miners until mature. They form a silk-lined hibernaculum in the mine in which they overwinter. But one generation occurs. The insect is completely parthenogenetic. The birch leaf miner, *Fenusa pumila* Klug differs in all of the foregoing points.

Native parasites are attacking this sawfly in increasing numbers and European parasites have been introduced.

The brown unsightly appearance of the leaves on ornamental trees has led to considerable spraying. Since the insect has spread westward into New York, it seems desirable to publish spraying recommendations in advance of a forthcoming bulletin. Four years of spraying work has shown that this insect can be controlled with one application of nicotine sulphate and soap or Penetrol. Nicotine sulphate 1 to 800 with soap is recommended. This has given 100 per cent kill in experimental tests and good control on large trees in the hands of commercial spraying companies. In experimental work in the field, dilutions of 1 to 1000 have given 99 to 100 per cent kill, and 1 to 1500, 98 to 100 per cent kill. These weaker dilutions have not been tested with power outfits on large trees. The time of application is very important as the larvae become highly resistant after the second instar. The egg stage is nineteen days and the eggs are killed by the spray. It is recommended that the spray be applied when the oldest mines reach a diameter of one-fourth to three-eights inch. This is from July 20 to 30 in central Maine. An application at this time or slightly later has given satisfactory control of both the sawfly and the birch skeletonizer, *Bucculatrix canadensisella* Chamb.

Preliminary work indicates that Bordeaux mixture 3–3–50 applied in central Maine June 12 to 20 and twelve days later will give fair protection.

A. E. BROWER, *Maine Forest Service*

The Effect of Low Temperature on the San Jose Scale in Georgia. Many southern peach growers believe that an unusually low temperature for the latitude of Georgia kills a large percentage of the San Jose scales on peach trees, and some even omit the dormant spray for scales if the weather is very cold. An opportunity was presented this year to determine the reduction in the percentage of live scales in an unsprayed peach orchard (A) as a result of a very low temperature. The data are given in the

	Before freeze		Freeze		After freeze		Reduction
		Average percentage of live scales		Minimum temperature		Average percentage of live scales	in percentage of live scales due to low temperature
Orchard	Date		Date		Date		
A	Feb. 4, '33	92.0	Feb. 9, '33	11.9°F.	Mar. 17, '33	57.2	22.3
B	Feb. 23, '32	85.5	Mar. 10, '32	18.0°F.	Apr. 25, '32	54.0	36.8
C	Feb. 23, '32	92.0	Mar. 10, '32	18.0°F.	Apr. 25, '32	59.0	35.9

accompanying table together with data on the effect of a fairly low temperature on scales in two unsprayed orchards (B and C) six miles apart in the spring of 1932.

There was a larger percentage of young scales on the trees when the freeze occurred in 1932, as there had been no cold weather before that time and reproduction had been heavy during the winter. Cold weather before the freeze in 1933 had retarded reproduction. Young scales are more susceptible to low temperature than the half-grown forms, and that accounts for the difference in the reduction of scales during the two years. The data indicate that unusually low temperatures in southern latitudes do not kill the majority of San Jose scales on peach trees.

OLIVER I. SNAPP and J. R. THOMSON, *U. S. Bureau of Entomology, Fort Valley, Ga.*
OLIVER I. SNAPP

Many Bark Beetles Destroyed by Predacious Mite. The economic value of mites as predatory agents in the control of bark beetles has never been fully realized. These minute arthropods are related to the spiders and were found by the writer in great numbers beneath the bark of ponderosa pine trees infested with the Oregon engraver beetle (*Ips oregoni* Eichh.). Other investigators have recorded mites associated with the mountain-pine beetle (*Dendroctonus monticolae* Hopk.) in western white pine, and with the Douglas-fir beetle (*D. pseudotsugae* Hopk.) in Douglas fir, but very little other information is available concerning their association with bark beetles. Owing to their microscopic size and agility, great difficulty was encountered in determining accurately the population of these creatures in infested ponderosa pine bark, but an examination of 9 square feet showed a range of from 138 to 2,265 mites per square foot.

The activities of these tiny creatures in association with *I. oregoni* were watched under various conditions, and they were observed to feed voraciously on the eggs of this bark beetle. There are also in this station records of mites feeding on eggs of *D. pseudotsugae*. As practically no information concerning the total egg mortality of bark beetles is available, it is difficult to calculate the actual reduction in the various bark-beetle broods caused by mites. However, by counting the number of normal eggs of *I. oregoni* and the number of eggs on which mites were feeding, it was learned that from 10 to 85 per cent of the eggs were devoured. This varied from 52 per cent egg mortality caused by mites in the first generation of Ips to 85 per cent mortality in the fifth generation, with from 10 to 25 per cent in the intervening generations. One other record shows the egg mortality of *D. pseudotsugae* to be 62.5 per cent of the total number laid, and no doubt this mortality is in a large part due to mites.

Four species of mites have been found in infested ponderosa pine bark, but not all of these are predacious. Those destroying the most eggs belong to the genus *Parasitus*. As they have no wings, they are forced to depend upon their host for transportation from the old brood trees to those which are newly attacked. Just prior to bark beetle emergence the mites fasten themselves to the adult beetles. On Ips they are found clinging to the concave declivity and beneath the wing covers, whereas on the *Dendroctonus* beetles, which have a convex declivity, the mites are found under the abdomen and beneath the wing covers. As many as 42 mature and immature mites were found clinging to one adult of *I. oregoni*.

Because of this means of transportation, the mites arrive at the newly-attacked trees with their host and consequently start to feed just as quickly as egg-laying

begins. The adult female mite fastens her beak in the egg and sucks the juices. As she feeds she increases in size and when all but the eggshell has been completely consumed she begins to lay eggs. These are laid in a group around her body and are held together by a sticky fluid. The greatest number of eggs found in one of these groups was 60. Only a few days are required for the incubation of these eggs, and upon hatching the young mites scatter beneath the bark in search of food.

It is possible that mites are the most important biological agent in the destruction of various species of bark beetles. The mortality in the larval stage of certain bark beetles due to all predators and parasites except mites averages between 20 and 30 per cent, whereas the mites destroy an approximate average of 50 per cent of some bark-beetle broods.

H. J. RUST, *U. S. Bureau of Entomology*

***Ptinus tectus* Boieldieu.** This peculiar little brown or "pitchy-red" beetle appears to have first been taken in California in Salinas, on September 30, 1932 by H. A. Hunt, County Agricultural Commissioner of Monterey County. The insect occurred in great numbers in stocks of fish meal. Specimens were determined by Dr. F. E. Blaisdell. In looking up the history and economic status of this new pest of stored products I find that it was first collected in Tasmania (Van Diemen) and described by Anatole Boieldieu[1] in 1856. T. H. Beare[2] states that it was first observed in a granary at Strood, England in 1901 which is the first record of its introduction into Europe. Since that time it has frequently been reported as a pest of stored products in different countries. Some of the more important published accounts are:

England—In army biscuits. J. H. Durrand and W. W. O. Beveridge, Jour. Royal Army Med. Corps, London, vol. 20, pp. 615–634, 1913.

In chocolate and cayenne pepper. J. J. Walker, Ent. Mthly. Mag., vol. 51, pp. 18–19, 1915.

In stored grains. Bur. Biol. Technology-Leeds, Bul. 2, p. 52, 1921.

In stored cacao. A. W. Knapp, Bul. Imp. Inst., London, vol. 19, pp. 189–200, 1921.

In packets of desiccated soups, waste flour, and dead insects. G. B. Walsh, Ent. Mthly. Mag., vol. 59, p. 258, 1923.

In stored hops. F. V. Theobald. Ann. Rept. Res. and Adv. Dept., S. E. Agr. College, 1926–1927, pp. 1–16, 1927.

In Cacao. J. W. Munro and W. S. Thomson. Rept. on Insect Infestation of stored cacao. London, 40 pp., 4 pls., 46 refs., 1929.

Ireland—Infesting casein and eating holes in woollen carpets. G. H. Carpenter. Econ. Proc. R. Dublin Soc., vol. 2, pp. 259–272, 1920.

Scotland—It is also listed from this country by N. H. Joy. A Practical Handbook of British Beetles, vol. 1, p. 455, 1932.

Germany—In prepared fish food and dried meats. M. F. R. Scholz. Entom. Blätter, Berlin, vol. 16, pp. 23–24, 1920.

In stored products. F. Zacher. Die Umschau, Frankfurt, M., vol. 26, 4 pp., 1922.

In cacao. F. Zacher. Verb. Deutsch. Ges. angew. Ent., vol. 5, pp. 68–69, 1926.

In poultry feeds. H. von Lengerken.
Mitt. Ges. Vorratschutz, vol. 5, pp. 21–26, 2 figs., 17 refs., Berlin, 1929. Also in Z. angew. Ent., vol. 14, pp. 450–460, 1929.

[1]Trans. Soc. Ent. France, vol. 4, p. 552, 1856.
[2]Ent. Mthly. Mag. (2), vol. 5, pp. 4–5, 1904.

In paprika. H. von Lengerken. Z. angew. Ent., vol. 15, pp. 639, 1929.
Finland—J. Salberg. Meddel Soc. Fauna Flora fennica, Häft 40, pp. 12–15, 1914.

Other species in the family Ptinidae with similar habits are the cosmopolitan *Ptinus fur* Linn., which is perhaps the most widely distributed, numerous, and destructive member; *Trigonogenius globulus* Sol., *Gibbium psylloides* (Czemp), and the more restricted *Niptus crenatus* Fab., *N. hololeucus* Falderm.; *Ptinus brunneus* Dufts.; *P. villiger* (Reit.); *P. raptor* Sturm, and *P. lichenum* Marsh.

This insect may have been introduced into other parts of this country and has been confused with some of the above.

E. O. Essig

A Laboratory Method for Determining Approximately the Evaporation of Petroleum Spray Oils Under Field Conditions. The method used for determining the volatility of the various grades of petroleum oils depends upon the use for which the oil is intended. For spray oils of the lubricating type the Bureau of Chemistry and Soils uses a method in which 20 grams of oil are weighed into a Petri dish or an evaporating dish having a diameter of 3½ inches; the dish and contents are placed in an electric oven, heated at a temperature of 110° C, for 4 hours, cooled in a desiccator and finally reweighed, the loss in weight being recorded as the percentage of volatile oil. In making tests at this laboratory on oils for emulsions to be used against scale insects, it was found that while the pure oils conformed to the manufacturer's specification with regard to Saybolt viscosity and unsulfonatable residue, the volatilities determined by this method were by no means in accord with the manufacturer's specifications. The discrepancies were due to the fact that the manufacturer had used a different method.

The method employed in the petroleum industry, known as the A.S.T.M. D6–27 (cf. determination of loss on heating, Institution of Petroleum Technologists Standard Method of Testing Petroleum and Its Products, pp. 102–105, 2nd ed. (1929), W. Speaight and Sons, Ltd., London) differs to a considerable degree from the method of the Bureau of Chemistry and Soils. For example, the A.S.T.M. D6–27 specifies that 50 grams of oil be weighed out and subjected to a temperature of 163° C. for a period of 5 hours. The samples are placed upon a shelf in an oven of specified dimensions. The shelf revolves at the rate of 5 to 6 revolutions per minute. Holde also discusses a number of other methods (D. Holde, The Examination of Hydrocarbon Oils, and of Saponifiable Fats and Waxes. Authorized translation from German. 5 ed. by E. Mueller, Eng. ed. 2, pp. 181–184, John Wiley and Sons, Inc., New York (1922)) applicable to the testing of engine oils.

Most methods for determining volatility are devised primarily to ascertain how an oil will stand up when it is used as a lubricant in steam and internal combustion engines and subjected to the high temperatures and pressures occurring in the cylinders. In combating scale insects the conditions are entirely different. When applied to plants and insects in the form of dilute emulsions, the oil spreads in a comparatively thin film over wide areas. The film covers the scales and is retained on the leaves and twigs for weeks. Evaporation usually occurs gradually and at a temperature which is no higher than outdoor temperatures.

A procedure which approximates the conditions of evaporation occurring on plant surfaces has been tentatively adopted at this laboratory. It is a modification of a method given by Scott (W. W. Scott, Standard Methods of Chemical Analysis, 4th ed., Vol. II, p. 1117, (1925), D. Van Nostrand Co., New York) which was originally

intended for estimating the evaporation of spindle oils. An annular disc of filter paper (1⅝ inches outside diameter, with a center hole of ⅝ inch diameter), which has previously been dried in an electric oven at 100° F. for a period of several days is placed upon a plain glass 2 inches square, and weighed to tenths of a milligram, and about 0.2 gram of oil is dropped on the paper from a small pipette. The glass, paper, and oil are then accurately weighed and placed in an oven, the temperature of which is adjusted at 100° F. (37.8° C.) for 24 hours. After the glass, etc., are reweighed, the percentage of loss due to evaporation is recorded.

The advantage of the modified Scott method is that evaporation of a small quantity of oil spread over a relatively large surface takes place over a long period of time at a convenient constant temperature only slightly above atmospheric. The rate of evaporation may be affected if grades of filter paper with varying porosity are used; however, with a standard paper this objectionable feature can be obviated.

The data below show the volatility of eleven blends of oils determined by the method of the Bureau of Chemistry and Soils, and the method proposed, and of two oils determined by the A.S.T.M. D6–27 method. The samples were obtained by mixing two pure oils known as "White Rose" and "L-1778," respectively in the proportions shown.

Sample No.	Blend of Oils*	Evaporation as determined by diff. methods		
		A.S.T.M.	Bur. chemistry	Proposed
		%	%	%
1	100:0	0.9	0.3	1.4
2	90:10		0.3	1.4
3	80:20		0.4	1.5
4	70:30		0.7	1.5
5	60:40		1.1	1.8
6	50:50		0.5	1.4
7	40:60		1.0	1.5
8	30:70		1.3	1.6
9	20:80		0.9	1.7
10	10:90		1.4	1.8
11	0:100	1.0	1.7	1.6

*White Rose: L-1778

The data suggest that "volatility" is an arbitrary term depending upon the method of determination. Apparently a different kind of evaporation occurs under the conditions of the proposed method as the variation from sample to sample is not great. Many other corroborative figures have been derived from tests. For all spray oils tested which were of specifications acceptable to manufacturers and growers, the evaporation rates range from about 1 to 2 per cent. One manufacturer claimed a volatility of 8.6 per cent for an oil known as "Extra White Rose"; when tested by this method it showed an evaporation of only 1.6 per cent. It is thought that for oils which come strictly within the lubricating class the volatility factor in spray work is relatively unimportant provided only 1 or 2 per cent evaporates during the test.

De Ong (Specifications for Petroleum Oils to be Used on Plants, Jour. Econ. Ent., Vol. 21, No. 5, pp. 698–699, October 1928) has suggested a method similar to the proposed method in which the oil is spread out upon asbestos paper. However, he uses temperatures between 50 and 100° C. and obtains a distillation curve rather than a definite evaporation figure under a standard set of conditions.

L. H. DAWSEY, *Assistant Chemist, Insecticide Division,*
Bureau of Chemistry and Soils, New Orleans, La.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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A. A. A. S. Winter meetings: 1933-34 Boston; 1934-35 Pittsburgh; Summer meetings: 1933 Chicago. 1934 San Francisco.

Occasionally a question arises as to the advantages of membership in the American Association of Economic Entomologists. The general aspects were summarized in the preceding issue, and at present we are concerned with a more restricted phase. The Association made possible the publication of this JOURNAL and, practically speaking, it certainly could not have attained its present size and influence throughout the world without the backing of the Association. A brief comparison between subscription prices for the JOURNAL and those for five other similar publications indicate that these latter, were they to print an equivalent number of pages, would cost nearly $8.00 each, whereas the subscription price of the JOURNAL is but $3.50, and for members of the Association only $2.50. Granting that the JOURNAL is worth its nominal subscription price to non-members, the actual membership fee in the Association would be but fifty cents. In other words, members of the American Association are paying fifty cents for the support of a National organization, and in doing this, they are also providing a very important though not necessarily perfect medium for the publication of scientific papers. In the earlier days, the Proceedings of the Association were published by the then Federal Division of Entomology, they appearing some nine months after the meetings. This should be contrasted with the JOURNAL publishing the Proceedings, sometimes a considerable proportion of them, within three months after the meeting is held.

Furthermore, it is well to bear in mind the fact that opportunities for publication through National and State agencies are much more limited than in those early days, and judging from the developments of the last few months, they are likely to be restricted to a considerably greater extent. The JOURNAL OF ECONOMIC ENTOMOLOGY is the one general medium for the publication of economic papers in America. Its embarrassments are due largely to the great demands for its facilities. It is the agency which distributes throughout the world somewhat promptly, occasionally very promptly, the results of investigations in economic entomology. It is suggested that the relatively few who question the advantages of membership in the Association give careful consideration to the above and also attempt to picture the situation were we to revert, an extremely unlikely eventuality, to the conditions of earlier days. The experience of the JOURNAL has demonstrated the advantage of one well supported National serial, and while for a time our publication facilities may be somewhat inadequate, the solution is not to be found in the establishment of other agencies, but in the strengthening of the one which has already abundantly justified its existence.

This is a period of readjustment. No sensible person can deny the need for economy. It is probable that the peak of official entomological work has been passed for a time, at least. We may expect adjustments, possibly painful adjustments, and these may extend over a series of years. They may force a number of entomologists to look for other opportunities, although there is no question as to the fundamental value of research. We must face the fact that governmental agencies may not find themselves at liberty to invest to the same degree as formerly in this type of activity. We have departments of Zoology and Entomology in some of the larger institutions, and it is quite possible that in others not directly interested in agriculture, entomology might well be made a more prominent part of the course. The medical field is an inviting one to entomologists. Our larger medical colleges, state health departments, health officers in larger cities and the larger hospital organizations could all profit greatly by expert entomological knowledge applied to their special needs, and in some cases this has been made available. The more practical applications of entomology along agricultural lines are also worthy of consideration by entomologists. The inspection services of the various States need the best information available in regard to the constantly arising new problems and the numerous county agents throughout the country find insect troubles among their more important problems. The Superintendents of the larger farms and estates, large landscape companies, and the larger State, county and

RAYMOND LOUIS NOUGARET

(1866–1933)

park commissions are also in need of direction in this field. A number of insecticide companies are profiting by the services of expert entomologists, and it is probable that others have similar needs. The forestry departments in States and the larger lumbering companies are fields which have not been adequately developed. It is possible that entologists during the past few years have stressed research unduly, although it is a prime essential to progress in applied work. The present is certainly an opportune time for giving careful consideration to openings for entomologists along the more immediately practical lines. Service is the criterion in the long run, and there is no doubt but that the country needs all of its entomologists. The question is, are they meeting the more urgent needs of the present? Are there not numerous places where entomologists are greatly needed? There is no time like the present to find or develop them. It is the well trained specialist who sees the opportunities and meets the situation.

Obituaries

RAYMOND LOUIS NOUGARET[1]

Raymond Louis Nougaret, entomologist and viticulturist, and member of the American Association of Economic Entomology since 1913, died suddenly of angina pectoris in Izmir (Smyrna), Turkey, January 10, 1933. "Letters written Christmas Day and New Year's stated that he was well and enjoying the holiday festivals."

He was born in New York City, N. Y., on April 8, 1866, and grew up in that metropolis, where after a year in the public schools, his elementary education was completed during the six years spent in St. Louis College. He then went to France and attended, first the Lycee de Montpellier four years, and the Ecole de Pharma, Montpellier, 2 years. At the latter he studied, among other subjects, chemistry, viticulture, and entomology. The following two and one-half years were spent at the Ecole d'Agricole, Montpellier, where he studied viticulture and oenology, receiving there the A.B. degree. After somewhat more than a year of practical work in France he returned to New York City and later came to California to privately practice viticulture.

On January 1, 1911, he was appointed Agent in the Bureau of Entomology, his status being changed to Entomological Assistant on Sept. 1,

[1]The writer is greatly indebted to Mrs. R. L. Nougaret, Dr. C. L. Marlatt, W. C. Jacobsen, and Harry Stiner for much of the information contained in this obituary notice.

1911. "His appointment was recommended to carry on an investigation of the grape phylloxera, including the collection of data on the distribution and injury of the insect, the variation in injury to different varieties of Vinifera grapes, and other problems connected with the behavior of this insect in vineyards." He spent much of the period from 1911 to 1917 in charge of a laboratory at Walnut Creek, California, where he was for a time associated with W. M. Davidson of the same Bureau.

The results of his extensive work on the biology of the grape phylloxera during this period were published jointly with Davidson.[2]

The period from 1917 to 1919 was largely spent in the San Joaquin Valley with headquarters at Fresno. In cooperation with M. H. Lapham, of the Bureau of Chemistry and Soils, a comprehensive study was made of the grape phylloxera in relation to types of soil, an investigation which was made after he became a member of the State Department of Agriculture; the results of which were published jointly by Nougaret and Lapham.[3] During his stay in Fresno he conducted some investigations on the use of sulfur fumes for the control of the grape mealybug and other insect pests of grapevines, the results of which were published in 1918–1920.[4] He also did some work on the Mediterranean fig scale.

On August 31, 1919, he resigned from the Bureau of Entomology to accept a position as Viticulturist in Charge of the Office of Viticulture, California State Department of Agriculture with headquarters at Sacramento, where he remained until January 15, 1927. During this period he traveled extensively and rendered services in all phases of viticulture throughout the state. Full credit should be accorded him for the services which he rendered to the grape growers in perfecting methods used in determining grape maturity and in the standardization of this important product.

In 1927 he accepted the position of viticulturist of the Fontana Farms, Fontana, California, and remained there until he signed a two-year contract, plus a two-year option with the Turkish Government in 1931. He went to Turkey on the recommendations of W. A. Taylor, Chief of the Bureau of Plant Industry, U. S. Department of Agriculture, to

[2]Davidson, W. M., and Nougaret, R. L. The grape phylloxera in California, U. S. Dept. Agr., Bul. 903, Prof. Paper, 128 pp., 10 figs., 10 pls., April 22, 1921.

[3]A study of phylloxera infestation in California as related to types of soils. U. S. Dept. Agr., Tech. Bul. 20, 38 pp., 2 figs., 1 pl., 1 col. map, February, 1928.

[4]Grape mealybug, Mthly. Bul., Cal. State Dept. Agr., vol. 7, pp. 511–514, figs. 67–69, 1918.

The achemon sphinx moth, Ibid., vol. 8, pp. 560–584, figs. 146–162, 1919.

Sulphur fumigation, Ibid., vol. 9, pp. 26–31, 83–85, figs. 24–25, 1920.

A termite pest of vineyards, Ibid., vol. 9, pp. 327–330, figs. 89–91, 1920.

reorganize and assist the raisin industry there, and although he was greatly interested in and pleased with the success and progress of the work, he found the task a most difficult one due to the many problems involved in changing, not only the ancient methods of viticulture, but also in modernizing and harmonizing the ideas of growers and packers.[5] His difficulties were greatly increased by the serious financial crisis in Turkey which permitted only the strictest economy and resulted in the failure to adequately support the plans as agreed upon by the government.

According to his own word he organized the Institute of Viticulture (Bagcilik Enstitüsü) at Bournabatt—a suburb six miles from Izmir. The Government also has a small Agricultural College and a Laboratory at the same place. The Institute, however, never became a realization. The difficulties of securing adequate scientific apparatus from foreign countries had not been overcome before his death. That he succeeded in improving the quality of raisins in Turkey during this brief interim is shown by the fact that his exhibit at the Chamber of Commerce scored 10 points out of the possible 11 points for perfect.

He was certainly a man of high ideals and lived accordingly. What emoluments were denied him in life over there were more than lavished upon him in death. According to word from the American Consul: "The Turkish Government gave him an official burial. President Kamel Pasha sent a representative; the Director of Police and four aids; the Governor; the President, professors and students of the International College; the American Colony; prominent Turkish families; the Consul and Vice-Consul all attended the funeral. So he rests forever in a foreign soil and his name is added to the long lists of American Scientists who have given their lives for the benefit of humanity.

In addition to the papers already listed, the following appeared later:

Report of the Viticultural Service, Calif. State Dept. Agr., vol. 20, pp. 487–501, 7 figs., 1920; vol. 11, pp. 872–874, 1922; vol. 12, pp. 366–369, 1923; vol. 14, pp. 198–201, 1925.

A proposed treatment for frosted grapevines, Ibid., vol. 10, pp. 345–358, figs. 58–69, 1921.

The rootknot on grape, Ibid., vol. 12, pp. 139–150, figs. 61–64.

E. O. Essig

[5]Viticulture in Asia Minor is well described in an article prepared by Mr. Nougaret shortly before his death. This article entitled: The Smyrna Raisin Industry appeared in *The California Grower*, vol. 5, no. 3, pp. 12–13, March, 1933, and is apparently his last contribution.

FRED E. BROOKS

Fred E. Brooks, an active member of long standing in the American Association of Economic Entomologists and charter member of the American Entomological Society, died following several years of ill health which culminated in a heart attack on March 9, 1933 in his home at French Creek, West Virginia. He was born at French Creek, W. Va., on June 8, 1868. He attended the common schools of West Virginia and his further excellent education was received due to his own untiring efforts in reading and observation. He had no college degrees but his grasp of problems, both general and specific, would put to shame many of us who hold the Doctorate. In 1896 he married Miss Grace Coburn, who with two children, Maurice Brooks and Dorothy Brooks, survive him. In early life he was a fruit grower and his personal struggles with insect problems and his success in working out practical controls led him into entomology. In 1902 he was employed by the West Virginia Agricultural Experiment Station, first as Assistant and later as Associate Entomologist, which latter position he retained till 1911. While with the West Virginia Station he conducted extensive work with grape insects and small mammals, this work being recorded in numerous West Virginia bulletins and popular articles published during this period. In 1911 he became affiliated with the Bureau of Entomology as Associate Entomologist. He was in charge of Deciduous Fruit Insect Investigations for the Appalachian Region with headquarters at French Creek, W. Va. Due to ill health he resigned from the Bureau in 1928. His best known work was with the round-headed apple-tree borer and other wood-boring insects. In addition to this he also conducted extensive research with various nut insects, especially the weevils attacking chestnut; the codling moth, the walnut husk maggot, and others. Most of his research work is published in bulletins of the U. S. Dept. of Agriculture. In addition to entomology he was also keenly interested in nature generally and published many papers covering his observations in journals, such as *Nature*, *Country Life in America*, *Rural New Yorker*, and numerous others. As an observer of natural phenomena he was without a peer and it was in this way that he made his most notable contributions. In his passing, entomology loses a diligent and successful worker; the State, a conscientious and active citizen; and his friends, a friend indeed.

C. R. CUTRIGHT

Current Notes

Dr. W. E. van Steenburgh, Entomological Branch, reports excellent results in breeding *Trichogramma* in killed *Ephestia* eggs.

Mr. G. Wishart, Entomological Branch, notes that more than 25,000 adults of the corn borer parasite, *Macrocentrus gifuensis*, were liberated in infested areas in 1932.

A new incubator, built especially for rearing the corn borer parasite *Inareolata punctoria* was completed and installed in the Belleville Parasite Laboratory in Ontario by the end of February.

Mr. U. C. Loftin, senior entomologist, cotton insect investigations, U. S. Bureau of Entomology, recently returned to Washington, after having spent nearly a week in Puerto Rico making a survey of cotton conditions and the status of the pink boll worm in its relation to native hosts.

The reported drastic reductions and reorganization of the Federal Government led President W. E. Hinds to appoint a committee representing the Association and consisting of Messrs. Britton, Cory, Felt, Houser and Phillips (Chairman) to go to Washington and do whatever might be possible to conserve the essential features of the entomological investigations and services of both Federal and State agencies.

Mr. R. E. Balch, Entomological Branch, attended the meetings of the Pulp and Paper Association and the Canadian Society of Forest Engineers, in Montreal, January 26 and 27. A continuation of his study of the effects of recent defoliation by the birch skeletonizer, on birch, in New Brunswick, confirms the conclusion in last year's investigation that the birch stands have been perceptibly retarded in growth by this injury.

Dr. H. L. Parker of the U. S. Corn Borer Parasite Laboratory, Hyeres, France, and Mr. D. W. Jones of the U. S. Parasite Laboratory, Arlington, Mass., visited the head office, Entomological Branch, at Ottawa, on March 3, and addressed the members of the Entomologists' Group, of the Professional Institute, on their work in Europe and the United States. Before going to Ottawa they spent several days at Belleville with the officers of the parasite laboratory.

During the latter part of January, a shipment of more than 3300 parasitized overwintered larvae of the spruce sawfly, *Diprion polytomum*, was received at the Belleville Parasite Laboratory in Ontario, from the Farnham House Laboratory, England. An additional 6,000 larvae of *Cephus pygmaeus* parasitized by *Collyria calcitrator* were also received from this source. In addition, a shipment of pupae of Leucopis, a predator of balsam and pine Chermes, together with material containing larvae and pupae of another predator of these bark lice, was received during the period.

On the evening of April 7, 1933, a meeting was held of the entomological Society of Puerto Rico, in one of the laboratories of the School of Tropical Medicine. Officers for the ensuing year were elected. Dr. G. N. Wolcott presented a paper on "A Year's Experience with the Cottony Cushion Scale in Puerto Rico," which is to be published in the July, 1933 number of the Journal, Dept. Agr. Puerto Rico. The main speaker for the evening was Dr. W. A. Hoffman, who gave a demonstration of the trematode parasite of snails and man which causes the bilhartzia disease. The distribution of the parasite in the New World, and especially in Puerto Rico, methods of infection,

treatment and control were discussed. Dr. Hoffman showed living cercariae and ova under the microscope, and demonstrated the most recently devised methods of concentrating the parasites and testing for their presence. At present, the most important project being conducted by the Society is sponsoring the publication of Dr. Wolcott's "An Economic Entomology of the West Indies," which is now being printed.

Horticultural Inspection Notes

Transit inspection activities at St. Paul, Omaha, Council Bluffs, Portland, and Seattle, were discontinued for the season on May 15.

The next meeting of the Western Plant Quarantine Board will be held in Salt Lake City, Utah, on June 12 to 14.

The State Plant Board of Arkansas on March 16 canceled the rule relating to apple blotch which applied to shipments of apple seedlings originating in Kansas.

A quarantine proclamation (No. 80) relating to the red date scale (*Phoenicococcus marlatti*) was issued by the Texas State Department of Agriculture, effective on April 20, requiring a permit for the introduction of date palms or ornamental palms or offshoots, from Arizona, California, and New Mexico.

Field inspections of the environs of pine-growing nurseries whose proprietors have applied for Federal pine-shipping permits for the coming year are now being made by Messrs. R. A. Sheals, J. M. Corliss, and C. R. Stillinger of the Bureau of Plant Quarantine, in cooperation with Messrs. H. N. Putnam, L. W. Hodgkins, and R. G. Pierce, of the Bureau of Plant Industry, and the plant quarantine officers of the various States.

The Oregon State Department of Agriculture on April 22 reissued the quarantine pertaining to the vegetable weevil by reducing very materially the long list of plants heretofore designated as hosts of the weevil; and on April 25 reissued the quarantine pertaining to the potato tuber moth and the rootknot nematode. The latter pest is not now involved in the certification of potatoes under this quarantine.

Mr. G. L. Bond, Inspector of the State Plant Board of Mississippi, formerly located at Laurel, Mississippi, is now at Iowa State College where he will receive the Master of Science degree in entomology in June. On returning to duty, he will be stationed at Durant, Mississippi, temporarily relieving Mr. D. W. Grimes, who will secure his Master of Science degree in entomology during the summer quarter at Ohio State University.

Recent court decisions of interest to plant quarantine officers include a decree by the United States District Court for the District of Nebraska upholding the State cedar rust law, and an opinion by the United States District Court for the Northern District of New York, upholding a New York State law and regulation relating to cattle certification. Mimeographed synopses of these decisions have been prepared by the Bureau of Plant Quarantine, and copies were sent to the various plant quarantine officers on April 20.

According to a railway circular, the State of Michigan on March 15 lifted its quarantines relating to the chestnut blight and to the tall barberries and Mahonias;

and the State of Louisiana issued rules effective on December 1, 1932, requiring that shipments of certified seed Irish potatoes must be accompanied by the certificate and prohibiting the shipping of such certified potatoes in bulk. The railway circular also reports amendments to Texas proclamations 78 and 79, permitting the entry, under such amendments, of properly labeled shipments of avocados into north Texas and of boxed citrus fruits into two additional counties in the non-citrus area.

Changes in the European corn borer quarantine situation include the establishing of new or amended orders on the part of Indiana, Idaho, and Illinois. The Indiana quarantine, effective on May 12, relates to the two-generation strain of the borer, provides for acceptance of certain products under certification, and places no restrictions during the period from January 1 to June 1 on green corn on the cob and young floral plants. The Idaho quarantine issued February 15, 1933, provides for acceptance of the products when certified and for ears of seed corn for exhibition purposes when subject to heat. This quarantine includes Wisconsin and Virginia among the list of States designated as infested. The principal changes in the Illinois quarantine of May 1 include the acceptance without restriction, during certain portions of the year, of green corn on the cob and also of chrysanthemums, asters, and dahlias without the previous year's stems; the removal of the provision for acceptance of seed corn on the cob for exhibition purposes when subjected to heat; and removal of the following from the list of restricted articles: oat and rye straw, celery, zinnia, hollyhock, and cosmos.

The recent revision of the Postal Laws and Regulations provides for an alternative procedure for expediting and simplifying the handling of plant shipments for terminal inspection by State inspectors. Heretofore the destination postmaster has been required to send the plants, at the addressee's expense, to a designated terminal inspection point for examination and return. This involved considerable delay and often resulted in damage to the plants. Many State quarantine officers have accordingly asked for authority to make the inspection while the package is en route and before it is delivered to the destination post office. Accordingly the present regulations provide that packages may be addressed to the addressee *in care of the State plant inspector at the proper inspection point.* The plants are inspected and the parcel is then forwarded by the inspector to the addressee, the forwarding postage being collected from the latter. It is necessary, however, for the shipper to guarantee such forwarding postage. The plant quarantine officers of one or two States are reported to have proposed this arrangement to the principal shippers who send nursery stock and other plants into their State. If plant quarantine officers of other States which have adopted the terminal inspection plan wish to work out such an arrangement, information as to its operation may be secured from the Bureau of Plant Quarantine.

The annual meeting of the National Plant Board was held at St. Louis, Mo. February 28, 1933. Seven of the eight members comprising the Board were present. Progress was reported in the preparation of a set of Principles of Pest Eradication. These are to be fundamentally similar to the Principles of Plant Quarantine approved by the regional plant boards and drawn by the National Plant Board two years ago. The desirability of uniformity in State quarantines concerning the phony disease of peach trees was thoroughly discussed. A motion was adopted "That the Board recommend to States who wish to adopt a quarantine re phony disease of peach trees, that such States accept stock from a nursery where no phony disease has been found by an authorized inspector within a mile from the nursery, or in lieu of that, all peach

nursery stock must be inspected by an authorized inspector tree by tree and certified as free of the peach root borer. Infected phony trees within a mile must be destroyed, as must also all borer infested nursery stock. The restricted articles shall be the same as those of the former Federal quarantine." Federal certification of plants and plant products to meet the requirements of State quarantines was approved by the Board. Under these conditions standards of inspection would be maintained by State and Federal governments which would be acceptable to both the sending and receiving States. Present at the meeting were Chairman W. C. O'Kane, Vice Chairman G. A. Dean, Secretary R. W. Leiby; members T. F. Adams, A. G. Ruggles, M. S. Yeomans; also Geo. M. List representing the Western Plant Board. Visitors included Lee A. Strong, S. A. Rohwer, L. H. Worthley and K. C. Sullivan. Members of the National Board also attended the meeting of the Central Plant Board on the following day.

At the meeting of the Central Plant Board held at St. Louis on March 1, H. B. Hungerford of Kansas was elected as President; P. T. Ulman of Indiana, as Secretary, and K. C. Sullivan of Missouri, as representative on the National Plant Board, with G. A. Dean, whose term has not expired. Resolutions were adopted recommending against the imposition of State quarantines except in emergencies, especially while the present serious economic conditions prevail. The Board also recommended that if possible the word "quarantine" be eliminated as a term to designate regulatory measures designed to prohibit or otherwise regulate interstate plant movement; that the requirements relating to fees and bonds be simplified or eliminated, and that where Federal quarantines are discontinued the Bureau of Plant Quarantine and the National Plant Board devise methods which will permit interstate movement of pest-free plant materials. Other subjects presented included a talk by Lee A. Strong, Chief of the Bureau of Plant Quarantine, on developments in quarantines during the past year; also a general discussion on closer cooperation between the States and the Federal government. It was agreed that if the States having phony disease infections would incorporate into their inspection requirements the recommendations of the National Plant Board with regard to that disease, the members of the Central Plant Board would not impose quarantines on nursery stock shipments from infected States. It was further recommended that the European corn borer quarantine restrictions on host plants of the two-generation strain be limited to the two-generation area in case Indiana, Ohio, Michigan, and other States in the one-generation area promulgated quarantines against the two-generation area. The next meeting will be held early in March, 1934, at Lafayette, Ind.